



Campbell 2. a.

J. Campbell

(Copy of the Report with
Several papers found in it
the places to which they refer.
Also the drawings from
which the illustrations were
made. —

Tuesday May 21. 1867.
attended the Third Meeting at the Institution of
Civil Engineers at the invitation of Chance

The Institution of Civil Engineers.

Established 1818—Incorporated 1828.

SESSION 1866-67.

25, GREAT GEORGE STREET, WESTMINSTER, S.W.

May 3rd, 1867.

THE Secretary begs to inform Mr. Laupphell
that the following Paper will be **READ** at the Meeting of Tuesday Evening,
MAY 7th, at Eight o'Clock, when the Council hope he will be able to
be present and take part in the discussion.

"On Optical Apparatus used in Lighthouses."

By JAMES T. CHANCE, M.A.

It is suggested that Members and Visitors should come prepared to
discuss this subject, and should send any Illustrations, or Models, on or before
Monday, May 6th.

IN CONSEQUENCE OF THE PUBLICATION OF UNAUTHORIZED AND INCORRECT VERSIONS OF THE DISCUSSIONS AT
THE MEETINGS, MEMBERS AND VISITORS ARE PARTICULARLY REQUESTED TO AVOID MAKING ANY
REPORTS OF THE PROCEEDINGS, SUCH PRACTICE BEING CONTRARY TO THE REGULATIONS OF THE
INSTITUTION, AND PRODUCTIVE OF INCONVENIENCE.

No. 22.

NOT TRANSFERABLE.

I undertake to abide by the Regulations of The Institution of Civil Engineers, and not to aid
in any unauthorized publication of the proceedings.

Signature
of the
Visitor. }

managed now in this country. But
in the stores he showed cases in
which light was wasted as much
as ever.

Gambell 2. a.

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Tuesday, May 21. 1867.

attended the third meeting at the Institution of Civil Engineers at the invitation of Chance who read a paper at the first meeting of which he is to send me a copy. -

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"Mr. Forster the President called on Mr. Campbell the Secy to the Light House Commission & he got on his knees & legs and said: "First that all the information which he had to give was out of date. "all the knowledge of the subject which he had, "was gained while acting Secy to the "Commission, & ~~after the report was~~ "published he had not thought of the "subject since the report. Since then he "understood that great improvements had "been made. With reference a comparison "made by the Astronomer Royal between a "Cathodic & Didtore light at South Foreland "last mentioned by Mr. Siemens the previous "Speaker, and explained by some deep "difference in waves of light; the Secy was "in a position to give a simple reason for "the unfavourable comparison. The "Didtore light apparatus was wrong set "and the flame was bad. - Great "part of the light was thrown on the sky & "lost a ship crossing the channel "only saw the points of the flame. &c

Admiral Raper rose and said that he had no doubt things were well managed now in this country. But in the stores he showed cases in which light was wasted as much as ever.

on a previous occasion Gladstone who was present at this third meeting spoke for a long time and (as he says) took my name. He hopes not in vain about the method of internal observation.

On one of the nights the astronomer Royal spoke. Admiral Hammett was present one night.

It seemed to me that the talk was all over old ground. Dioptric & Catoptric, & that matters had advanced very little since the Commission reported except as regards in Scotland.

Then Stevensons had set Siemens to work and amongst them they had produced a novelty which was exhibited at the meeting.

The engineering of the Trinity house seemed to be exceedingly novel & diagonal lantern bars which he had caused to be made of steel instead of bronze & which after all these years the Trinity House have adopted from the N L Board.

Generally so far as I could gather the tone of the meeting the subject of light house illumination is very much where I left it 50 years ago.

Shew this to Gladstone, Hammett, & the Astronomer Royal. See page 10 Report

The dioptric apparatus in the United Kingdom is not always arranged so as to be turned to the best advantage. The amount of light produced is often deficient.

The apparatus is often so adjusted as to waste a great part of the light produced

DUBLIN, Nov. 23.

The Rev. Dr. Romney Robinson, Astronomer Royal, has addressed a letter to the Inspecting Committee of the Ballast Board on the lighthouses of Ireland, which he has recently inspected. He bears testimony to the perfect cleanliness, order, and discipline which he found in all the 36 lighthouses which he visited and in the dwellings attached to them. The most critical eye, he says, could find nothing to blame, and the keepers and their families, with scarcely one exception, might serve as patterns of what Irishmen may become under a system of judicious kindness combined with just and firm control. In some of the wild island stations the snugness of the houses contrasts strangely with the savage desolation around them, and must do so more powerfully in the gales of winter. Dr. Robinson states in a note that, when leaving Gola Sound, though the gale was much abated, the waves were 20ft. high, and of such power that they made a clear sweep over the Stags of Aranmore, 45ft. above the sea level. Dr. Robinson looked at those abodes with the eye of a Christian and a benevolent man. In case of illness in rough weather it might be days before a medical man could get out to one of the lighthouses. He therefore recommends that each lighthouse should be supplied with a medicine chest, with remedies for ordinary maladies—such as cold, dyspepsia, or diarrhoea. Another great privation to the families on those lonely rocks is the want of education for their children, and Dr. Robinson suggests the establishment of a school in Dublin for their special benefit. Referring to the object of these establishments, Dr. Robinson makes remarks, which may apply to lighthouses everywhere. He says:—

"With respect to the optical part of your lighthouses, I was glad to see how largely you use the dioptric system. I was not prepared to find it so extensively employed in the Irish lights, nor, I think, is the public. Of its superiority to the catoptric I have no doubt, and I have now got an additional evidence. At Rathlin, when asking the keepers about the visibility of the different lights around them, I found that 'they saw the Maiden's (distant 27 nautical miles) in very clear weather.' At the Maiden's they saw Rathlin habitually; it was a good and strong light.' Both lights are first-class, but Rathlin is dioptric; yet, though the latter kind are so much more powerful, I think those which I have seen (with the exception of Rockabill) are still susceptible of improvement in the following matters:—In some of the earliest—for instance, Ballycotton, which in other respects is perfect—some of the reflecting prisms are of very green glass, and a few so full of striae that they cannot add anything to the illumination, and ought to be replaced by good glass. In some cases the prisms are not properly adjusted, and their light does not go where it is wanted. I was glad to hear that the commissioners are employing a competent person to set this to rights. When once properly adjusted, they are not likely to get out of position without much violence. The same may be said of the mirrors which are substitutes for prisms at St. John's Point, county of Down. These mirrors would be much improved if, instead of the amalgam of tin which coats them, they were silvered; but prisms would be preferable, especially as this light is red."

Dr. Robinson tells the Ballast Board that they are not properly appreciated, and he had himself but a very imperfect idea of the enormous amount of work they do and do well. He thinks the "Report on Lights and Beacons" was drawn up in no friendly spirit towards them, and that they would do well if they made themselves better known.

The large passenger ship Royal Standard, Captain Allen, from Liverpool for Melbourne, went into Cork harbour on Wednesday, at 6 o'clock, having left Liverpool on Monday morning. As soon as she entered, the heads of the police got along side, and told the captain they wanted two young men, named London and Warwick, on the charges of committing a forgery upon the Northampton Bank for 3,000*l*. The delinquents were soon found, travelling under the names of Harry Vincent and Charles Dickens. They were arrested, and on their persons was found the sum of 1,235*l*. They had, besides, a most costly outfit. They looked on the proceedings by which their course was arrested with the most perfect indifference.

DUBLIN STOCK-EXCHANGE, Nov. 23.

Government Funds.—Three per Cent. Consols, 91½ ¼; New Three per Cent. Stock, 90½ ¼; ditto, for account, December 10, 90½; ditto, for new account, January 12, 90½; Banks.—(Hibernian Banking Company (25*l*. paid), 30½; National Bank (30*l*. paid), 78½; Royal Bank (10*l*. paid), 28½. Steam.—City of Dublin (100*l*. paid), 115½ ex. div. Mines.—General Mining Company (limited) (4*l*. paid), 3½ ¼; ditto for account, 3½ ¼; Mining Company of Ireland (7*l*. paid), 10½; Wicklow Copper (all paid), 12½. Miscellaneous.—Grand Canal Company (100*l*. paid), 47½. Railways.—Dublin, Wicklow, and Wexford (all paid), 9½; Great Southern and Western (100*l*. paid), 93½; Midland Great Western and Royal Canal Half Shares (all paid), 24½. Railway Preference.—Dublin, Wicklow, and Wexford, 6 per cent. perpetual (all paid), 13½; Great Southern and Western, 4 per cent. perpetual (100*l*. paid), 100½; Irish North-Western, 4 per cent. perpetual, Class A (all paid), 6½.

1863. Nov. 27. -

Doctor. R. R. is the best evidence of the justness of the strictness on the Irish lights. -

There are no medicine chests. -

The prisons are ill set. -

The reflectors are not silvered but tin. -

The Ballast Board are not up to the mark of the other boards. - in these respects. -

The Commission reports in favour of scientific inspection and the send them astronomer. They are who was set out by the Commission at first. See his evidence. and now it was got.

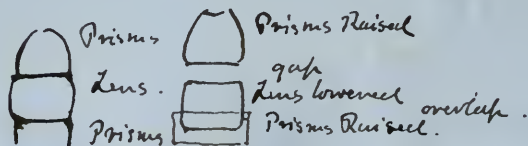
November 17. (18. attended another meeting and listened in silence to a lot of twaddle and an advertisement of Chamber's works. -

Next meeting did not go though asked and wrote to Fowler to say that I had little to do with it - but that I could put the authorities up to a clue for setting them prizes. Thought it was going to Ruby in the train here it is.

To clip the ray.
 Raise prisms.
 Lower lens.

The Prisms
 come into a
 different set
 of rays when
 raised.

This should be done at the workshop when the light apparatus is overhauled. To do it at the light house. a new the frame work would in some cases have to be cut and gaps filled.



The present system of setting prisms is like breaking a spectacle glass to alter the focus.

This is no new contrivance it is but a return to old arguments in which the astronomer Royal's plan no matter what was adopted while any other was rejected without further notice. It has paid Chance remarkably well but I don't think that the lights are much bettered.

See page 5. of the Engineers paper Nov. 17.

[PRIVATE PRESS.]

THE INSTITUTION OF CIVIL ENGINEERS.

NOVEMBER 17, 1868.

CHARLES HUTTON GREGORY, Esq.,
PRESIDENT,
IN THE CHAIR.

This was the first meeting of the Session 1868-69, and it was held in the New Building, erected during the recess, and upon the completion of which, according to the promise made by the Council, the President congratulated the Members; taking occasion to remark, that the Council had placed upon their private minutes a unanimous vote of thanks to the architect, Mr. T. H. Wyatt. The President observed that the contractors, Messrs. Holland and Hannen, were also entitled to commendation, for the manner in which they had carried out the works, within the time specified in the contract—a result to which the personal care of the Secretaries had largely contributed.

The Paper read was “On Lighthouse Apparatus and Lanterns,” by Mr. David M. Henderson, Assoc. Inst. C.E. It was stated that this communication might be regarded as a sequel to the Paper “On the Optical Apparatus of Lighthouses,” by Mr. James T. Chance, M.A., Assoc. Inst. C.E., read during the Session 1866-67.

The glass used in lighthouse apparatus was nearly all made at Saint-Gobain or Birmingham, and was of the kind known by the name of crown glass. Different mixtures had been employed for

ONERS

EMENT OF
ACONS.

B. HAMILTON,

EX.

Presented to both Houses of Parliament by Command of Her Majesty.



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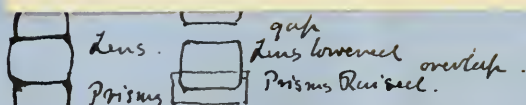
FOR HER MAJESTY'S STATIONERY OFFICE.

1861.

November 17. 18.
 meeting and list
 of twelve. and
 of Chambers's w
 Next meeting
 and write to
 I have little to
 I could put
 a check for
 Thought it out
 To run here it

To dip the
 Raise prisms.
 Lower lens.

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 think that the lights are much bettered.

See page 5. of the Engineers Paper Nov. 17.

the purpose; but M. Reynaud, the Director of the French light-
 house service, now gave the composition as—

Silica	72.1
Soda	12.2
Lime	15.7
Alumina and Oxide of Iron	} . traces.

100.0

At Birmingham various mixtures had been tried, of which
 several examples are given, the following being about an
 average:—

	cwt.	qrs.	lbs.
French Sand	5	0	0
Carbonate of Soda	1	3	7
Lime	0	2	7
Nitrate of Soda	0	1	0
Arsenic	0	0	3

English glass was supposed to be of the refractive index of 1.51.
 That produced at Saint-Gobain had formerly an index of refraction
 as low as 1.50, but now it was 1.54, and frequent experiments were
 made to ascertain that the standard was maintained.

The furnace for melting glass was generally rectangular in plan,
 and was constructed of the most refractory materials; and the
 sides were arranged so as to allow of the easy withdrawal of the
 pots. Six, and sometimes eight, pots were placed in the furnace,
 arranged in pairs with a firegrate at each end. The flame filled
 the whole interior of the furnace, and, after circulating round the
 pots, which were covered to prevent the colour of the glass being
 injured by dust, or impurities from the coal, found its exit by flues.
 Great care was necessary in the preparation of the pots, which
 were made of about one-half new fire-clay, and one-half old pot-
 sherds, finely ground. The length of time a pot would last de-
 pended upon (1) the quality of its manufacture; (2) its being
 slowly and thoroughly dried—a process occupying about six months;
 and (3) the care bestowed upon it in the furnace, and whilst with-
 drawn for casting. The average number of castings from each pot

was about twenty ; and the time the pot was out of the furnace at each casting was about three minutes. It was mentioned that Mr. Siemens' Regenerative Furnaces were now in use for the manufacture of lighthouse glass with perfect success. When the metal was ready for casting, each pot was lifted from its seat, withdrawn from the furnace, and carried to the foot of a crane, the lifting chain of which had attached to its end a clip to embrace the pot. A mouth-piece of wrought iron was fitted to the pot before casting, to facilitate the pouring, and the workmen tipped over the pot, by means of long handles.

The casting table was circular, and was mounted on a frame, so that by means of a handle it could be turned round, and each part of its outer circumference brought consecutively under the pot of molten metal. The moulds into which the glass was to be cast were arranged round the outside of this table, and were caused to revolve slowly under the continuous stream of liquid glass flowing from the melting pot, so that each mould was filled in succession, thereby enabling the immediate return of the empty pot to the furnace. The moulds were of cast iron, of a uniform thickness of $\frac{5}{8}$ -inch, and were supported on feet cast on, the size being such as to allow $\frac{1}{8}$ -inch thickness of glass all round for the grinding process. The small lens-rings and prisms were cast in one piece, but the larger ones were cast in segments. The large belts, or central lenses for fixed lights, were generally cast flat, and were afterwards bent on a saddle to the required curve in a kiln.

Sand, emery, rouge and water were the four necessities for glass grinding and polishing. The sand had to be applied, with abundance of water, until it lost its cutting qualities. The emery, after being ground to a fine powder, was agitated in water, and the mixture was passed through a series of vats or tubs, so that the emery was divided into as many qualities as there were tubs, the coarsest being deposited in the first tub, the finest in that furthest from the supply. The rouge, which was an oxide of iron, was prepared from the sulphate, and was separated into qualities by means of water tubs, as in the case of the emery. The glass of optical apparatus was ground on horizontal circular tables, securely

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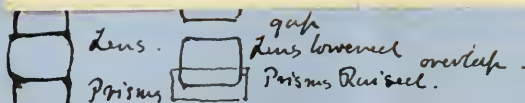
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fastened to the tops of wrought iron vertical spindles, which received motion from the main shafting in various ways. The surfaces of these tables were divided out, like the face plate of a lathe, to receive the different sizes of 'carriers,' or supports of cast iron, which were bolted to them, and were arranged to hold the lenses or prisms to be ground. Plaster of Paris was then laid on the 'carriers' in bands, the bands being reduced to the exact size by turning the table round under a gauge secured to the framing of the machine. The glass was laid on these strips, and was secured in place by means of pitch, care being taken in the larger sizes, which were ground in segments, to place a thickness of pitch between each joint, so that glass did not touch glass. A detailed account was given of the method of grinding a belt, or central lens, of a fixed light, and also of grinding a bull's eye or central piece of an annular lens.

The various sizes of catadioptric lights were next given in detail; and it was stated that, in order to produce a distinction between different lights, some were fixed and others revolving, while there were many combinations of the two classes. Again, there were modifications to render fixed lights intermittent, and colours had also been employed, to both fixed and revolving lights.

In reference to the method of mounting the lenses and prisms, it was remarked that sea-lights on account of their size and weight, were necessarily divided into several portions. The section of the apparatus, consisting of lower prisms, lenses, and upper prisms, gave a convenient division into three tiers, each of which was subdivided into panels of a convenient size. In a first order fixed light, the circumference was divided into eight panels of 45° each, which were made of gun-metal racks, or side pieces, formed to receive the lenses or prisms, these side pieces being connected together by gun-metal segments of rings at the top and bottom. The Author then proceeded to describe minutely (1) one segment of a first order light, in which all the joints of the panels were vertically over each other; (2) an arrangement with inclined lens-panels, the upper prism panels being so placed that their joints did not come vertically over those of the lower prism panels;



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(3) a first order apparatus, where the upper and lower prisms were fixed; (4) an eight-sided revolving light, collecting the whole light into eight beams of parallel rays; and (5) a first order apparatus, commonly called a 'Fixed Light varied by short Eclipses,' a title which did not convey the actual effect, as the fixed light was followed by an eclipse, then a flash, and next an eclipse, the same phases being continually repeated.

The construction of the panels was referred to in detail; and it was observed that, when the fitting was finished, the panels were taken to the erecting shed, where they were erected on their pedestals, or on, what was more convenient, a revolving table, specially constructed so that each panel, or part of a panel, could be brought in succession opposite the erecting post. The prisms were passed into their places, one end covering plate of the panel to be set being removed, and wooden wedges were used to support the glass and enable it to be accurately adjusted in its position by means of internal observation, as explained by Mr. Chance in his Paper. When the prisms were adjusted, plaster of Paris was applied at all the corners, to retain the prisms in their correct position, and when fairly set, the wedges were removed and the remaining spaces filled in with best red lead putty.

The arrangement of panels generally adopted was that of placing one panel over the other, so that the joints should be vertically over each other. It had in its favour simplicity, a minimum loss of light, a minimum cost, and strong, convenient-shaped panels. These advantages had been considered of such importance, that in France this method was still adhered to, and all the lanterns were constructed with vertical standards placed in front of the obscuration caused by the sides of the panels. This plan, however, rendered as many points, on rather small arcs, on the sea as there were standards in the lantern, to be illuminated with a considerably weaker light. The late Mr. Alan Stevenson was the first to introduce inclined lens-panels, with a view to equalise the distribution of light on the sea, but he was no doubt well aware, that the total loss of light would be increased. Inclined standards had been adopted in several instances, but without any

so that an apparatus is constructed without any reference to position & elevation.

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1861.

My copy of 1861

November 17. 68.

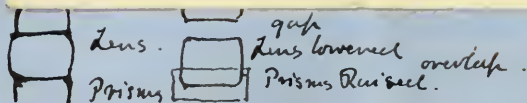
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alteration in the optical apparatus. The horizontal divergence, resulting from the size of the burner in a particular case alluded to, might be taken at 6° , and the standard was inclined over an angle of $7\frac{1}{2}^\circ$ in plan, so that when an observer was placed in front of the standard, it nearly stopped off the light from him throughout its entire height, commencing on one edge of the flame and finishing on the other, thus obstructing much light which had successfully passed through the apparatus. The lantern of Mr. Jas. N. Douglass, M. Inst. C.E., the Engineer to the Trinity House, was designed to render impossible a correspondence, or optical coincidence, between the framing of the apparatus and that of the lantern. In the Author's opinion, this lantern was expensive, from the amount of workmanship of a costly class, and from the glass cut to waste.

An arrangement had been designed by the Author, with a view to obviate the objections to previous methods. The first consideration was the optical apparatus, and it was apparent, that a minimum amount of light was stopped by vertical panels, and that it was possible to divide the previous large obscurations into a greater number of smaller ones, thus equalizing the light without increasing the total obscuration. By excentering, or placing the various tiers of panels so that their joints did not come vertically over each other, each previous obscuration was divided into three. The amount of excentering necessary depended upon the size of the flame, so as to enable one obscuration to be completely passed before entering upon another. In a first order, for example, the panels were 45 each; and, as there was an intermediate rack in the prison panels, there was a space of $22\frac{1}{2}$ between each obscuration. Each large obscuration could be divided into three small ones, which, if placed at intervals of $7\frac{1}{2}$, would never allow more than one obscuration to be visible at a time. The next consideration was the lantern, which, when arranged with excentered panels, was rendered less rigid, owing to its weight not being transmitted continuously downwards, as was the case with vertical continuous standards. This want of rigidity would be objectionable in a light illuminating the whole horizon, but in those illumi-



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nating from 180° to 270° , (which were by far the most common,) the dark arc could be filled in with solid iron plates, by which any amount of rigidity could be obtained. By the substitution of triangular frames in the central tier, it was still possible to retain the upper and lower panels excentered, and to render the framing perfectly rigid, in fact more so than with the vertical continuous bars of the old lanterns.

A detailed description was then given (1) of a first order lantern with inclined standards, (2) of the lantern to which the French engineers adhered for all apparatus burning oil, and (3) of the lantern arranged by the Author to ensure the most uniform distribution of light.

The three principal varieties of lamps in use for sea lights were the mechanical, the high reservoir, and the pressure. The mechanical were the most general, being used in Scotland, France, and many foreign countries. The oil was forced over the burner by pumps, which were worked by clockwork placed underneath and driven by a weight. One of the best high reservoir lamps was that designed by Captain Nisbet, of the Trinity House, and which had been applied to several English lighthouses. Lamps of this class were not, however, applicable to revolving lights, or those illuminating all the horizon, on account of the obstruction of light that would be caused by the reservoir. The pressure lamp of M. Degrand, of Paris, was next noticed. In it the oil was forced over the burner by means of a weight pressing directly on the surface of the oil. It was found that the large space between the piston and the cylinder in this lamp rendered the leather packing liable to turn over when the oil got heated, and softened the leather; added to this, there was no provision for varying the weights on the piston. To meet these objections, M. Masselin designed a lamp with external weights which gave excellent results, and had the advantage, not possessed by the high reservoir lamps, of being equally well adapted for fixed and revolving lights, whether the whole horizon was illuminated or not. This lamp was minutely described; and in the next section of the Paper an account was given of a first order clockwork, consisting of two trains of wheels, one for driving the apparatus, and the other for

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1861.

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driving a fly wheel with adjustable vanes for regulating the speed.

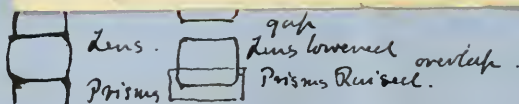
In conclusion, the means adopted for lighting the entrance to Odessa harbour were described. At the extremity of one breakwater a tower was built, to contain a fourth order optical apparatus fixed for 270° , with a metallic reflector for the remaining 90° . At the extremity of the other breakwater a beacon was erected, but it was required that a light should be shown without there being a lamp, or any metallic reflector, at that place. Accordingly a sixth order holophote was placed in the tower, to collect all the light from its lamp into one beam of parallel rays, which was thrown across the entrance to the harbour to illuminate the beacon, producing thus what was called an Apparent Light. On account of the distance of the beacon from the holophote, 300 feet, much light was lost, and the divergence of the beacon was small, but ample for what was required, as it was placed low, and a range of only about 1 mile was required.

The communication was accompanied by fifty-six large diagrams, and by six sheets of carefully executed drawings to a reduced scale.

It was announced that the discussion upon this Paper, which had been commenced, would be resumed at the meeting of Tuesday next, the 24th inst., when, time permitting, the following Paper would be read: "Roman Rock Lighthouse, Simon's Bay, Cape of Good Hope," by Mr. J. F. Bourne, M. Inst. C.E.

A Report was brought up from the Council stating that, under the provisions of Section IV. of the Bye-Laws, the following Candidates had been admitted, since the last announcement, Students of the Institution: Charles Toler Burke, George Ernest Faithfull, Henry James Samson, and Herbert de Symons Skipper.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 24th, at 8 P.M., 1^o Discussion upon Mr. Henderson's Paper, "On Lighthouse Apparatus and Lanterns;" and 2^o "Roman Rock Lighthouse, Simon's Bay, Cape of Good Hope," by Mr. J. F. Bourne, M. Inst. C.E.



The present system of setting prisms is like breaking a spectacle glass to alter the focus.

This is no new contrivance it is but a return to old arguments in which the astronomer Royal's plan no matter what was adopted while ~~that~~ any other was rejected without further notice. It has paid Chambers remarkably well but I don't think that the lights are much bettered.

See page 5. of the Engineers Paper Nov. 17.

REPORT
OF
THE COMMISSIONERS
APPOINTED TO INQUIRE INTO
THE CONDITION AND MANAGEMENT OF
LIGHTS, BUOYS, AND BEACONS.

TOGETHER WITH A

LETTER FROM REAR-ADMIRAL W. A. B. HAMILTON,
CHAIRMAN OF THE COMMISSION,

AND

APPENDIX AND INDEX.

VOL. I.

Presented to both Houses of Parliament by Command of Her Majesty.



LONDON:

PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.
FOR HER MAJESTY'S STATIONERY OFFICE.

1861.

Handwritten signatures and marks at the bottom of the page.

1813. Noted. Felling's quotation & drawing as the cotton

1 Report from Foreign Countries. in May, came in

América. Omist the novel at the top of the page

~~44~~ 45

46.

47

48

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51.

América

Peru

Holland

Sweden

Stambury

Melation

Spain.

Come in —

~~27~~ 28. Reports of local authorities in England. with the observations of the Commission.

27/28

Scotland 23. Stills
Melrose 14 stills

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papers to given entire money it has been
provisionally inserted in 34- 35- or 36
The papers to follow each other in ascending
order. From East by South ~~South~~ West
to North. on the right ^{beginning} of the 34-
one to be covered

~~§ 41~~ Evidence collected through Procurement Service as ~~§ 37~~
~~§ 41~~ Procurement evidence to be finally arranged as ~~§ 37~~

§ 41 Provisions evidence to be finally arranged & new family.

2013 Abstract of Murders' Evidence. -
2013 1st ed. Foreign Questions to Men out in the Street
2013 1st ed. Foreign Questions to Men out in the Street

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1864 and 1865 + another connecting. in the same

11/18 Wed. Fokien anathem to Denmark in the afternoon
1864 and 1865 + another connecting. in the same

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the A-nong + another country - do they come to

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the A-nong + another country - do they come to

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the A-nong + another country - do they come to

xviii) tried Fokien anation to draw out by the other
the A-nong + another country - do they come to

35—36.	Lights, &c.,	in France.—West Coast.
36.	Do.	in Spain.—North do.
36—38.	Do.	in France.—West do.
38.	Do.	do. South do.
38—41.	Do.	do. North do.

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 44. First meeting with the Astronomer Royal, at Millbank Street.
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 46. Visit of Col. La Touche to 7, Millbank Street.

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as the Special Light House Cattle.

22 Boys & Beavers arranged in the order
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23 — Return to 14 (a) 5.

Report of Commissioners for Northern Districts of Ireland
The above Scotland to be printed at the

~~Street~~ ~~page~~

Page 85

24 — On Constitution of Province. No 24 slips

25 On General Light House. as above

26 Special Cattle. as above

27 — Boys & Beavers. as above.

28 — Return to 14 (a) 5

Report of Commissioners for Ireland as above

— on Constitution

Light House

29 Special & —

30 Special & —

31 Special & —

32 Boys & Beavers.

33 Return to 14 (a) 5

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1. Questions as to Constitution of House -
Power of Sec. 5 -
Power of Sec. 5 -

2. General. & Special Digital Storage

3 General & Special. Hermit's dish-

4. Muesy & Breun.

5. Scientific Questions

Report of March-Home continued

on Contribution of 150000

#18
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in the order of the Quebec Finances?

~~7~~.19

Special Agent Robert Armstrong

In the order in which they may be seen
each Order to study one Column only

and the answers to the kept as recently, but

positive on the same level throughout

The report -

General. Fluctuating light medium average in

- | | | |
|--------|--------------|------------------------|
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| 36. | Do. | in Spain.—North do. |
| 36—38. | Do. | in France.—West do. |
| 38. | Do. | do. South do. |
| 38—41. | Do. | do. North do. |

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3. General report. Formed on all the letters
with conclusions signed by the Commission -

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4. Report of Commission on Personal Hypothesis of
English Men & Russians under the name General
its own name formed in England, Scotland and
Ireland. Which will include -

5. (a) The first this leaving out observations on ~~myself~~

the social conditions and incidents

6. (b) Conclusions drawn from Russian Evidence

7. Conclusions drawn from alleged Evidence

8. Conclusions drawn from Personal Russian Evidence

9. Conclusions drawn from Scientific Evidence

10. Separate observations made by individual

members or anything else that may be

added, to each of the above. ~~Personal~~

if we allow to be made in the report must

be done so that they may be

good on the information is gathered

Personal observations made by members

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of Ireland & according to state

11.

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Opposite to the questions references are given to the pages where the replies may be found. Some abstracts are given, and other information is added.

Each reply is numbered to correspond to the question to which it is an answer.

Example 1.—It is desired to know what is the description of illuminating apparatus at any lighthouse—under any of the General Authorities—

Open out Circular III., and the Question will be found as (No. 21) XXI.

Search in the map for the number of the Lighthouse in question; say No. 1 Fern, in England.

Search for No. 1. under the heading—Circular No. III., England, and the information will be found, Vol. II. p. 65, opposite to the No. XXI., and the same information for every Lighthouse will be found opposite to the same Number,—XXI.

Example 2.—It is desired to know the opinion of John Smith, Mariner, as to the best shapes and colours for buoys.

Open out Circular VIII., Mariners' Questions, and the question which elicited the information will be found opposite to —No. 17.

Search for Smith's number in the alphabetical list of Mariners, page 466, and opposite to his name is the number 292.

Look for 292, under the heading—Question 17, Mariners' Evidence, page 526, and the evidence of John Smith on this point will be found:

"292. The nun buoys, black or red, are best seen at night."

Example 3.—It is desired to know what is the bearing of the evidence given on the same point by the whole of the witnesses.

Look to the Abstract, page 587, and the result of the evidence of 657 witnesses will be found opposite to Question 17, which elicited the information. Vol. I. p. 110.

Example 4.—Information is wanted relative to a Local Authority; say Liverpool.

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Example 5.—The opinion of a Scientific Witness is wanted on any point raised by a question in Circulars IX. and X.

Search for his name, in the list on the Circular, and his evidence will be found under the number of the question.

Example 6.—Information is wanted as to some foreign country.

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-

Abstract of Commission

Light Floating Buoys Beacons
Structures. Light.

I. Inquire

Number _____

Neatly

Position

Efficiency

Sufficiency

Expense of Construction

of Maintenance

System of Management

of Control

Economy

Superintendence of Local Authority.

	Light Structures.	Floating Light.	Buoys	Beacons
Number	x	x	x	x
Neatly	x	x	x	x
Position	x	x	x	x
Efficiency	x	x	x	x
Sufficiency	x	x	x	x
Expense of Construction	x	x	x	x
of Maintenance	x	x	x	x
System of Management	x	x	x	x
of Control	x	x	x	x
Economy	x	x	x	x
Superintendence of Local Authority.	x	x	x	x
Certain Lights only.				
System for Construction	x			
Maintenance	x			
Control	x			
Economy	x			

2 Colonial

System for Construction

Maintenance

Control

Economy

- 1 British Lights Buoys & Beacons. - The Commissioners are directed to inquire into matters to which X is attached - They may
 - 1st System of Management which includes Trinity
 - 2^d System of Control which includes the Board
 - 3^d They are to consider Economy
 - 4 Superintendence of Local Authorities. The W. & A. are directed to the Mercantile Marine. Full reports on all the X are prepared.
- 2 Colonial. - They are directed to inquire and report on certain lights only - which & may be included only the Board of Trade.

may advise
changes in

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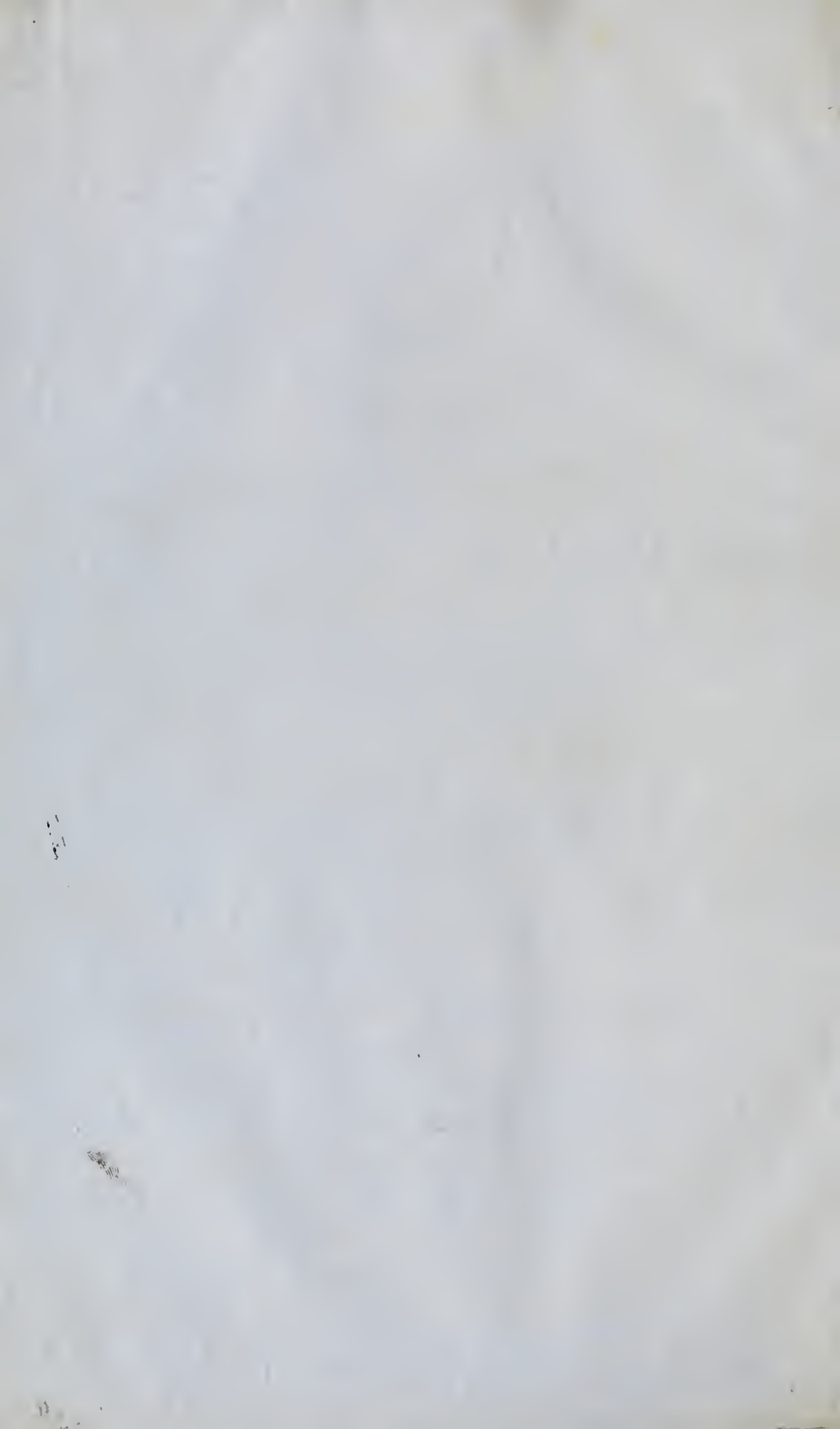
- Superintendence do
of Local Authorities

System for
put of

led to inquire and must report on all the
recommended alterations. in. System of Management
Wine, Scotch & Irish Wines.
of Trade. —

It includes the English Scotch & Irish Authorities & B. G. Trade
mine act

and interpretation, some are printed. —
next on System for Management & of
mental changes in that system which
superintendence



COMMISSION.

VICTORIA R.

VICTORIA, by the Grace of God of the United Kingdom of Great Britain and Ireland Queen, Defender of the Faith : To Our trusty and well-beloved WILLIAM ALEXANDER BAILLIE HAMILTON, Esquire, Rear Admiral in Our Navy ; ALFRED PHILLIPS RYDER, Esquire, Captain in Our Navy ; JOHN HALL GLADSTONE, Esquire ; DUNCAN DUNBAR, Esquire, Chairman of the London Local Marine Board, and SAMUEL ROBERT GRAVES, Esquire, Chairman of the Liverpool Local Marine Board ; Greeting :—

WHEREAS We have deemed it expedient that a Commission should forthwith issue for inquiring into the condition and management of Lights, Buoys, and Beacons : Now, know ye, that We, reposing great trust and confidence in your zeal and ability, have authorised and appointed, and do by these presents authorise and appoint you, the said WILLIAM ALEXANDER BAILLIE HAMILTON, ALFRED PHILLIPS RYDER, JOHN HALL GLADSTONE, DUNCAN DUNBAR, and SAMUEL ROBERT GRAVES to be Our Commissioners for the purposes aforesaid, and Our will and pleasure is that you, or any one or more of you, shall especially inquire into the number, quality, and position of the lighthouses, floating lights, buoys, and beacons on the coasts of the United Kingdom, both absolutely and relatively, as compared with the lighthouses, floating lights, buoys, and beacons on the coasts of any foreign countries, and into the sufficiency of the said lighthouses, floating lights, buoys, and beacons, for the efficient lighting and buoying of the coasts of the United Kingdom. And also, to inquire into the expense of constructing and maintaining the lighthouses, floating lights, buoys, and beacons of the United Kingdom, both absolutely and relatively, as compared with the expense of constructing and maintaining the lighthouses, floating lights, buoys, and beacons of any foreign countries. And also, to inquire whether the present system of management and control under which the lighthouses, floating lights, buoys, and beacons on the coasts of the United Kingdom are constructed and maintained, according to the provisions of the “ Merchant Shipping Act, 1854,” is well adapted for securing the most efficient lighting and buoying of the coasts of the United Kingdom, with a due regard to economy, or whether any, and, if any, what change might be advantageously made in that system. And also, whether any, and, if any, what further supervision or control might advantageously be exercised over any local authority having jurisdiction in the matter of lights, buoys, or beacons in the United Kingdom. And also, whether the system now in force for the construction, maintenance, and control of certain lighthouses in Our Colonial Possessions, under the superintendence of Our Government, is well adapted for ensuring the most efficient conduct of that service with a due regard to economy, or whether any and what change might advantageously be made in that system. And, for the purpose of enabling you, Our said Commissioners, to make the said inquiries, We do hereby authorise and empower you, or any one or more of you, to call before you all such persons as you may judge most competent, by reason of their situation, knowledge, or experience, to afford you correct information on the subject of this inquiry ; and also to require the production of all books, documents, papers, and accounts which may appear to you, or any one or more of you, calculated to assist your researches in the execution of the trust hereby reposed in you, and to inquire concerning the premises by all other lawful ways and means whatsoever.

And We do command and require you, or any one or more of you, to report to Us in writing, under your hands and seals, or under the hand and seal of any one or more of you, as soon as the same can reasonably be, your several proceedings by virtue of this Our Commission.

And We will and command, that this Our Commission shall continue in full force and virtue, and that you Our said Commissioners, or any one or more of you, may, from time to time, proceed in the execution thereof, and of every matter and thing therein contained, although the same be not continued from time to time by adjournment.

Given at Our Court of St. James's, the 8th day of December 1858, in the 22d Year of Our Reign.

By Her Majesty's Command,
(Signed) S. H. WALPOLE.

REPORT.

TO THE QUEEN'S MOST EXCELLENT MAJESTY:

WE, Your Majesty's Commissioners, appointed to "Inquire into the number, quality, and position of the Lighthouses, Floating Lights, Buoys, and Beacons on the coasts of the United Kingdom, both absolutely and relatively, as compared with the Lighthouses, Floating Lights, Buoys, and Beacons on the coasts of any foreign countries, and into the sufficiency of the said Lighthouses, Floating Lights, Buoys, and Beacons, for the efficient lighting and buoying of the coasts of the United Kingdom. And also to inquire into the expense of constructing and maintaining the Lighthouses, Floating Lights, Buoys, and Beacons of the United Kingdom, both absolutely and relatively, as compared with the expense of constructing and maintaining the Lighthouses, Floating Lights, Buoys, and Beacons of any foreign countries. And also, to inquire whether the present system of management and control under which the Lighthouses, Floating Lights, Buoys, and Beacons on the coasts of the United Kingdom are constructed and maintained, according to the provisions of the 'Merchant Shipping Act, 1854,' is well adapted for securing the most efficient lighting and buoying of the coasts of the United Kingdom, with a due regard to economy, or whether any, and if any, what change might be advantageously made in that system. And also, whether any, and if any, what further supervision or control might advantageously be exercised over any Local Authority having jurisdiction in the matter of Lights, Buoys, or Beacons in the United Kingdom. And also, whether the system now in force for the construction, maintenance, and control of certain Lighthouses in Our Colonial Possessions, under the superintendence of Our Government, is well adapted for ensuring the most efficient conduct of that service with a due regard to economy, or whether any and what change might advantageously be made in that system," do most humbly report to Your Majesty as follows:—

INTRODUCTORY.

The course pursued by Your Majesty's Commissioners in conducting their inquiry has differed from that of the Parliamentary Committees which have inquired concerning Lights, Buoys, and Beacons, whose members have in some instances expressed regret at their inability to visit the Lights, &c. and judge for themselves. Our course has also differed from that generally followed by Royal Commissions, who have relied for the most part on oral evidence. This has affected the form and arrangement of our Appendix, and we think it right to give the reasons which induced us to depart from the usual course, and to explain the arrangement which we have adopted.

Your Commissioners held their first formal meeting on the 19th of January 1859, and their first step was to prepare questions for the examination of the Lighthouse Authorities.

It appeared to Your Commissioners that as there were many Authorities having charge of Lights, Buoys, and Beacons in the United Kingdom, it would be highly desirable to put the same questions to all, so that the action of the authorities might be more readily compared.

These Questions were accordingly prepared, printed, and circulated, and they are now given in Vol. II. as Circulars I., II., III., IV., V. Each question in each Circular has a number affixed to it, and the answers given by the Authorities are numbered so as to correspond with the numbers attached to the questions. The Circulars open out so that the questions may serve once for all in reading the Appendix.

The Returns of the General Authorities in England, Scotland, and Ireland, are placed together, in the Second Volume at pages 3 to 278.

The Returns of the Local Authorities, including the Admiralty, follow, and are arranged together alphabetically in the same order; namely, 1. England, 2. Scotland, and 3. Ireland, also in Vol. II., pages 631 to 637.

The Replies to these Circulars given by the Board of Trade relative to the Colonial Lights are in Vol. II., pages 631 to 637.

Thus by opening out Circular No. I., at the beginning of Vol. II., the whole of the answers given in reply to that series of questions, by each Authority which has furnished returns, may be found, by looking at the top and margin of each page, where the num-

Commission.

Course pursued
by the Com-
missioners.

Circulation of
Questions

ber of the Circular and the name of the Authority making the return to it, and the number of the question to which the matter in the page is a reply, will be found as a running heading, &c. in the Appendix. The pages where the answers will be found are marked on each Circular.

Thus the reply given to Question 1, Circular I., by the first of the Lighthouse Authorities named, will be found next after the Circulars; and the reply given to Question 27, Circular V., by the Local Authority in Ireland, whose initial comes last in the alphabet, will be found at the end of the Returns from Local Authorities, Vol. II., page 424.

In order to form a satisfactory opinion of the efficiency of the existing lights, buoys, and beacons in the United Kingdom, both among themselves and in comparison with those of foreign countries, it seemed to Your Commissioners necessary to adopt the widest possible field of inquiry, by inviting the opinions of such a number of witnesses at home and abroad as would neutralize partiality or prejudice. Aware that such a course, if pursued in the usual way of summoning witnesses, would involve a very serious expense, we adopted the plan of using the printing press and the post. In this way more witnesses could be examined, and at a much smaller cost; and their evidence, when obtained, could be more readily compared, and more easily read and understood, when systematically collected and arranged.

When a number of persons examine a witness, there is always a tendency to depart from the special line of examination, both in putting questions and in giving answers, and the evidence becomes very voluminous. One subject grows out of another. *Viva voce* examination is always best for extracting the truth from the unwilling, but written questions are best for obtaining deliberate opinions from men anxious to give them. A professional man could not be called before a Commission without offering to pay him, not only for his expenses, but also for his loss of time. A great number of skilled opinions brought to bear together on a single fact, from independent sources, are more nearly conclusive, if almost unanimous, than a small number given separately. A number of answers to the same questions can be more readily compared than an equal number of answers to questions variously put in varying order.

Your Majesty's Commissioners accordingly prepared questions at different times, which were designed for various classes of the community. These were printed, and very widely circulated amongst those classes. Each was framed as far as was judged advisable so as to embody but one single idea, and point to a simple negative or affirmative reply.

The result has proved that many who could not leave their avocations have written their ideas; and men of all ranks and professions, and of all degrees of talent, have proved that when a set of questions were placed before them they would willingly devote some of their time and ability gratuitously to the public good.

Circular VI. was sent to the Agents for Lloyd's. The answers are numbered, printed, and placed together with the returns of the Authorities to whose jurisdiction the evidence applies. Those which seem to apply more particularly to portions of the coast under the jurisdiction of the Trinity House, are placed at the end of the Trinity House return; those which relate to portions of the coast under the jurisdiction of the Scotch and Irish General Authorities follow their returns; and those which relate to the Local Authorities follow their returns.

Circular VII. was sent to members of the classes most interested in the Mercantile Marine, such as shipowners, merchants, &c. All the answers given to each question are printed together, under the question, at Vol. II., page 425.

Circular VIII. was sent to the class who use the Lights, &c.; namely, Mariners. All their replies are in like manner printed together under the questions, at Vol. II., page 445.

Circulars IX., X. were prepared and circulated amongst those Scientific Men whom Your Commissioners believed to have given most attention to the branches of science which relate to Lighthouses, &c., and to Manufacturers of Illuminating Apparatus; and the replies received from these gentlemen, and from others who wished to state their views, and who applied for the questions, are printed together, and follow a set of these questions at Vol. II., page 589.

Circular XI. was sent through the Foreign Office to Foreign Governments; the replies received are arranged at Vol. II., pages 651 to 658.

Circular XII. was sent to certain Steam Companies whose vessels pass colonial lights, and is given, with the replies, at Vol. II., page 650.

By following this course Your Commissioners have been enabled to procure returns from 114 Authorities having the management, &c. of Lights, Buoys, and Beacons in the United Kingdom, the evidence of 1,184 witnesses, and returns from 13 foreign countries, all of which we have been enabled to arrange, so that any particular bit of evidence given in reply to any single question by any witness can be readily found (by looking for the name of the witness in the alphabetical lists, and for his evidence under his index number below each question), or the bearing of the whole on any one of the points raised may be considered at once, by looking to the Abstracts, which are given together in Vol. I., and follow the evidence in Vol. II.

The cost of examining each witness may be set down at the price of the printed circular, and the postage of two letters; and the testimony obtained was in such a form as to make its arrangement easy.

By summoning witnesses Your Commissioners could hardly have accomplished their object, at all events within the time, and only at a largely increased cost.

Abstracts and Summaries of the replies to these various circulars have been prepared as far as practicable, and are appended, with the questions, in Vol. I. pp. 103-120, in order that the substance of this mass of testimony may be seen at a glance, and in connection with the conclusions and recommendations which have been in a great measure founded upon it.

As, however, certain points remained on which information could be better elicited orally, representatives of the principal Lighthouse Authorities were examined in the usual way, and their evidence is given in Vol. I.

Your Commissioners have also circumnavigated Great Britain; and have visited the Channel Islands, and most of the coasts of Ireland, of France, and a part of the northern coast of Spain. We have personally inspected more than 200 Lighthouses, several have been visited more than once; and full minutes of our proceedings are printed in Vol. I. Our observations which relate to Local Authorities are generally placed together with the returns furnished by them.

Personal inspection.

The Report and Appendices are thus arranged :—

Contents of Vols. I. and II.

	{	Report.
	{	Chairman's letter.
	{	Personal Observations made by Your Commissioners at home and abroad.
Vol. I.	{	Papers drawn up by members of Your Commission, and Reports made by other gentlemen.
Report and Appendix I.	{	Abstracts and Summary of Evidence in Vol. II.
	{	Oral Evidence.
	{	Miscellaneous Returns and Correspondence.
	{	Maps and Plates.
	{	Index.
	{	Returns by the three General Lighthouse Authorities, with evidence from Lloyd's Agents, subjoined.
	{	Similar Returns from Local Authorities, with Lloyd's Evidence, and the observations made by Your Commissioners at the ports named, alphabetically arranged.
Vol. II.	{	Evidence from the Mercantile Marine.
Appendix II.	{	Evidence of Mariners.
	{	Scientific Evidence.
	{	Returns as to Colonial Lights.
	{	Returns from Foreign Countries.

Although, from their great bulk, it has not been considered expedient to print the whole of the Returns and Correspondence, together with the Charts, Diagrams, and Drawings amassed during our inquiry, yet their great value renders it advisable that they should be preserved for the use of the Lighthouse Authorities.

PLAN OF REPORT.

The inquiry which Your Majesty's Commissioners were directed to undertake has reference to :—

- 1st. Lights, Buoys, and Beacons in the United Kingdom.
- 2nd. Certain Colonial Lights under the management of Your Majesty's Government.

1st. As to the United Kingdom, the inquiry conducted by Your Commissioners necessarily arranged itself under the following heads, and the report is framed on the same principle :—

Points of Inquiry named in the Commission.	Lighthouses.	Floating Lights.	Buoys.	Beacons.
Number - - - - -	Pages. 4	Pages. 17	Pages. 19	Pages. 21
Position - - - - -	5	17	20	21
Quality - - - - -	6	17	20	21
Sufficiency as regards efficiency -	5	17	20	21
Expense of construction - -	14	18	21	21
Expense of maintenance - -	16	19	21	21
System of management for securing efficiency and economy - -	26, 31, 33	26, 31, 33	26, 31, 33	26, 31, 33
System of control for do. - -	22, 31	22, 31, 34	22, 31, 34	22, 31, 34
Comparison with foreign countries } in all the above particulars - }	5, 12, 15, 16, 28	19, 28	20, 21, 28	21, 28
Further Supervision over Local Authorities - - - - -	34	34	34	34
Change of system under Merchant Shipping Act - - - - -	39	39	39	39

As to the Colonial Lights under the management of Her Majesty's Government, the inquiry resolves itself into the following points :—

System for construction with regard to efficiency and economy	-	-	-	Page 37
" " maintenance " "	-	-	-	37
" " control " "	-	-	-	37
Change of system - - - - -	-	-	-	38

LIGHTHOUSES.

Number. The following Table shows the number and the nature of the Lights in the United Kingdom :—

Country.	Lights on Shore.			Floating Lights.	Total.
	General Authority.	Local Authority.	Total.		
England - - -	82	89	171	41	212
Scotland - - -	46	67	113	1	114
Ireland - - -	69	4	73	5	78
Total - - -	197	160	357	47	404

Of all the Lights under the General Authorities, and about half of those under the Local Authorities, Your Commissioners have obtained full returns, which will be found at length in the 2nd Volume. The Lights on shore, for which returns have been received, are classified in the following Table:—

Authority.	Light-houses.	Catoptric.	Dioptric, or Catadioptric.	Apparatus not stated.	Order of Dioptric Apparatus.					
					1st.	2nd.	3rd.	4th.	5th.	6th.
England—Trinity House	82	51	31	—	20	8	—	1	—	2
„ Local	49	35	14	—	1	1	3	4	2	2
Scotland—Commissioners of Northern Lights	46	14	32	—	16	4	—	9	—	—
„ Local	24	13	3	8	—	—	—	—	—	—
Ireland—Ballast Board	69	51	18	—	10	1	4	3	—	—
„ Local	6	—	3	3	—	—	—	—	—	—

The Index Map at the end of Vol. I. shows the *position* of the Lighthouses in the United Kingdom, and on a portion of the French, Belgian, Dutch, and Norwegian coasts. Very few complaints are made as to the position of Lighthouses by mariners, or the agents of Lloyd's, and those which are made are generally confined to three or four sites.

It will be seen, by looking at the Map, that the number is sometimes *insufficient*, because vessels might be within a very short distance of some parts of the coast, and beyond the estimated range of any lighthouse, even in clear weather; for instance, at Great Orme's Head on the approach to Liverpool.

The circles of light on the Index Map are taken from the Map published by the Board of Trade, and represent the column in the Admiralty List of Lights headed “*Miles seen in clear weather*,” but from the evidence before us, and from our own observations, the lights are not uncommonly seen at much greater distances. Any attempt to make lights so brilliant or so numerous as that one at least should be visible in fogs which are dense enough to obscure the sun, would necessarily fail; but any increase in the brilliancy of the lights will increase their range in hazy weather, and make them more efficient; and their number ought to be such as to ensure that one or more may always be within sight of a ship approaching a danger in ordinary weather.

The west coasts of Scotland and Ireland are still *insufficiently* illuminated; and the Channel Islands lying near the track of ships bound up Channel, and surrounded by rapid tides, have been left in a state of blameable darkness, although a light is now being erected on the Hanois Rocks on the West coast of Guernsey. A reference to the Index Map will best show the *positions* where the number of lights is *sufficient* or *insufficient*.

It will be observed, as respects *number* and *position* of lights, that the British coasts are *not* so well guarded as the French, for the lights are purposely so placed on the coasts of France as to “cross their fire.”

This may also be tested by comparing the proportion between the number of lights and the amount of coast line in England, Scotland, and Ireland, with the proportion between the number of lights and the coast line in France. The measurement of the coast line and of the islands in the respective countries is given in a table in Vol. I. p. 222; the number of Lighthouses is taken as before from the Admiralty List. From these data the following table is constructed:—

Country.	Number of Lighthouses on shore.	Coast Line.	Proportion.
England	171	Nautical miles, 2,405	1 for 14.0 Miles.
Scotland	113	4,469	1 „ 39.5 „
Ireland	73	2,518	1 „ 34.5 „
France	224	2,763	1 „ 12.3 „

Hence it appears that the lighthouses in France are more than three times as numerous, compared with the amount of coast, as in Scotland; but a considerable allowance must be made for the very large amount of mileage afforded by the Scottish islands and the bays on the Irish coast, which do not require a commensurate amount of lighting, as a light on an island or on one side of a channel will often obviate the necessity of a light on the main land, or on the other side. The lights in France appear to be nearly three

times as numerous, comparatively speaking, as those in Ireland; but if to the 73 Irish Lighthouses be added the 5 floating lights, the discrepancy is somewhat reduced. In England too there seems at first sight to be a somewhat smaller provision made for illuminating the coasts than in France, yet if the 41 English Floating Lights be added to the 171 Lighthouses, as indeed justice requires, England will be found to provide a light for every 11·37 nautical miles of coast, while France furnishes one for only every 12·3 miles.

As to the *position* of lights in France and in England, there is this notable difference: The English lights have been steadily and gradually increasing in *number* during the last two centuries and a half, additional lights having been placed, from time to time, wherever the interests of commerce demanded, and a sufficient pressure was exerted; while, on the contrary, the French lights were very few till 1825, when a grand comprehensive plan was undertaken of erecting a large *number* of additional lights, on what were considered the best *positions*, and of remodelling the whole system.

The coasts of the United Kingdom are better guarded than those of Holland, Norway, or perhaps any other country, excepting France.

QUALITY OF LIGHTS.

Quality.

The quality of a light depends mainly on the following points:—

- 1st. *The character of the source of light.*
- 2nd. *The character of the apparatus, by which the light is directed to where it is needed.*
- 3rd. *The adaptation of the source of light and the optical apparatus to one another, with a view to the requirements of the locality.*
- 4th. *The distinction of one light from another.*

Source of light.

1st. *The character of the source of light.* It is the invariable practice of the three General Lighthouse Authorities in England, Scotland, and Ireland, to derive it from the combustion of colza oil. Where metallic reflectors alone are used, the lamp is on the Argand principle; but where lenses are employed, a large central lamp is resorted to. The Argand burners vary in number from 1 to 30, and the central lamps differ in the number of concentric wicks. The Trinity House and Ballast Board, at the time of the commencement of our inquiry, used fountain lamps, and never employed more than three of the four concentric wicks (see Vol. I. p. 63), while the Scotch Commissioners retained a fourth in 1st order lights. The lamps in Scotland being mechanical lamps, were found also to cause a considerably greater consumption of oil (as 5 to 3), and therefore the production of a higher and more powerful flame than was produced in England or Ireland.

Mechanical lamps preferred.

The Local Authorities also generally employ oil lamps, but the oil burnt is not always colza. Liverpool, for instance, prefers olive oil; and the Admiralty and Newhaven still retain the more expensive sperm, the use of which was abandoned for various reasons by the General Authorities some years since. Gas is also burnt in many Harbour lights, and in the Beacon light at Northfleet, under the management of the Thames Conservancy; and in that as in many other cases, and in the United States, with a very satisfactory result.

To the subject of the height of the flame Your Commissioners have given much consideration. It will again be alluded to in this Report; but they are glad to be able to put on record here that the Elder Brethren of the Trinity House have lately admitted the propriety of returning to the use of the fourth wick, and are now making experiments with a view to ascertain the best possible description of mechanical lamp.

Your Majesty's Commissioners, however, are of opinion that the science of Lighthouse illumination is in a transition state, and capable of further development. We have conversed with a man who was actually employed in his youth in burning coal fires at Harwich for directing ships at sea; in fact the last coal light, that at St. Bees, was only extinguished in 1822; the use of oil does not seem to date back beyond 1730; and we now find inventions under trial which promise to transcend far the powers of even the four-wicked mechanical lamp in producing light. Gas might probably be advantageously employed in other than Harbour lights, where it is now frequently used.

An electric light, which is produced between carbon points by the revolution of magnets fixed on wheels worked by a steam engine, has been tried with great promise of success by Prof. Holmes at the South Foreland, and is to be further tried at Dungeness, or at the Start.

Another electric light, produced by galvanic action in a stream of mercury, has been exhibited by Professor Way, and proposed for adoption in lighthouses.

Several modifications of the Lime light, produced by an oxyhydrogen flame playing on a surface of prepared lime, have been exhibited, and are commonly used in lecture-

A greater use of gas approved of.
Electric light approved of.

May 20 1867. This bears the mark of its authorship Many
Men many minds. The secretary wrote this report but the Commission
REPORT OF COMMISSIONERS ON LIGHTS, BUOYS, AND BEACONS.

rooms and elsewhere; and these are now proposed for use in lighthouses. And the least powerful of these surpasses the best oil lamp in brilliancy, as the oil lamp surpasses the open coal fire.

When any of these are so perfected as to make their action certain, the optical apparatus now used, and made to suit large flames, will be out of date as much as the large tinned reflector which was first erected behind a large coal fire on the Tour de Cordouan, and which was then considered a great advance in science. Optical apparatus, to suit a very small and exceedingly brilliant source of light, $\frac{1}{4}$ th of an inch long, may be of small size, and finished and adjusted with all the accuracy of a telescope. Thick lantern bars, and the comparatively clumsy and costly brass fittings, which now interfere with light, may perhaps be done away with, and then the cost of apparatus may possibly be as much diminished as the quality of the light is improved.

2nd. *The character of the apparatus by which the light is directed to where it is needed.*

It may be well to state shortly what is aimed at in constructing Optical apparatus for Lighthouses before proceeding to show how far the object has been attained.

From any given source of artificial light, such as a point in the flame of a lamp, rays proceed in every possible direction until obstructed. The fact may be familiarly proved by observing that the light of a table lamp falls on every part of the spherical ground glass shade, except where the metal of the burner interferes.

The object of Lighthouse illuminating apparatus, whether constructed of glass or of metal, is to bend the rays which would naturally proceed in straight lines and illuminate a hollow sphere, so that those which would otherwise be wasted may be used and fall on points where they may be seen at sea.

Taking the spherical lamp shade as an illustration, those rays from the lamp which illuminate the upper portions should be so bent downwards as to double the illumination of the lower half, if the light is intended to be a fixed light, seen all round, and from the horizon to the base of the light tower; and all the rays should be further bent laterally, if it is desired to illuminate a narrow strip of sea, extending from the horizon to the base of the lighthouse; or the rays may all be collected and thrown on one or more spots of larger or less size wherever the light is wanted.

These last objects are sought to be attained in fixed lights placed at the end of narrow passages, and in revolving lights; and these last are made visible all round by causing the lenses, reflectors, &c., to revolve about the source of light, or with it about a centre.

The better the machinery and apparatus is contrived and executed, and adapted to the situation, the more the light produced from a given source is rendered available by directing it properly; and the less it is wasted by absorption, dispersion, or improper direction, the better is the *quality* of the apparatus, and the greater the economy of the fuel consumed in producing the light. It must be borne in mind that the economy in the fuel consumed is in exact proportion to the light used, and the waste to the light wasted; that light which is thrown on the sky is equivalent to oil thrown away.

There are two principal means by which it is sought to throw the light in the desired direction. The one is by silvered parabolic reflectors, and is called the "Catoptric" system; the other is by lenses of peculiar construction, and is called the "Dioptric" system. Sometimes the two systems are combined together, as in the ordinary "Catadioptric," and in Mr. Stevenson's "Holophotal" arrangement.

These silvered reflectors even are comparatively modern inventions, dating, in fact, from the close of the last century, and it is not 40 years since the first dioptric apparatus was constructed by Fresnel, in France, and lenses have only gradually replaced the reflectors in our country. The lenticular system, as now developed, varies greatly from that first proposed; and modifications are continually suggested. Manufacturers both at home and abroad have invested large sums in machinery and in improving the quality of glass; and where so much thought is bestowed, it is reasonable to anticipate further improvement.

The table already given (page 5), shows the proportion between the catoptric and dioptric lights at present existing in the three kingdoms. It will be seen that the principle of refraction is generally adopted in Scotland, while that of reflection still holds the numerical preponderance in England and Ireland, but it should be borne in mind that the lighting of the Scotch coasts is of a later date than that of the English.

It has been generally assumed that the dioptric is preferable to the catoptric system; but while Your Commissioners do not controvert this opinion, they have conclusive

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the result is
very patchy
work.

Character of
apparatus.

In the report
of the
Commission
the Chairman
wrote the
report to
the Commission
cut it to
bits. In
this case
the Secy
confided
himself to
working at
principles
where he
held opinions

See the
paper
written by
the Secy.
to that
day to the
Commission
for his views
about
the point
therein
referred
to. Vol II
P 625.

See also a set of proofs of this report (incomplete) bound
separately.

Somehow I still prefer my own skeleton report as shorter & terser and thus after writing & re-writing a good deal.

evidence that many of the catoptric lights in England are not only excellent in themselves, but exceed in efficiency the dioptric lights on its shores. The first part of Question 7, of Circular VIII., addressed to Mariners, runs thus:—"What British light have you usually seen farthest off?" and out of the 579 witnesses who have answered this question, the greatest distances are mentioned with reference to the lights at Lundy Island, the Calf of Man, Tuskar, Flamborough Head, Beachy Head, and Cromer, and the greatest numbers of witnesses mention Flamborough Head, the Lizard, Lundy, Beachy Head, the Start, and the South Stack, all of which (with the exception of the Lizard, which is catoptric fixed, and the Lundy and Start, which are dioptric revolving*) are catoptric revolving lights. We are, however, of opinion that this preference of the large reflecting lights arises not from any inherent superiority of the catoptric system, but from the fact that the dioptric principle, owing to errors of adjustment, has never yet been allowed a full and fair chance in the United Kingdom, and a saving of oil has also been unfortunately attempted in various ways, chiefly by the use of the inefficient fountain lamps, in all the dioptric lights with the exception of those in Scotland, which has not been considered in the great revolving catoptric lights with 30 Argand burners. This subject will be reverted to in the following section.

3rd. *The adaptation of the source of light, and the optical apparatus to one another, with a view to the requirements of the locality.*

Adaptation of
the source of
light and
optical appa-
ratus.

This ought to be considered with reference to the object which it is proposed to effect, namely, in most cases, to send a bright light to the sea-horizon, and at the same time to illuminate sufficiently the nearer portions of the sea. (See Plates 1 and 2 at the end of Vol. I., and Vol. I. p. 67.)

The source of light never is one luminous point, but a figure having length, breadth, and depth, and is composed of a vast number of luminous points, some of which are placed at considerable distances from others. The vertical and lateral divergence of lighthouse beams depends in a great measure on the size and shape, as well as on the position of the source of light placed in the apparatus; and though works on Lighthouse Illumination often mention the flame as if all its parts sent some portion of light to all places from which the light can be seen, such is not the fact. Lighthouse apparatus, like any other lenses or reflectors, form within the apparatus an image of the landscape outside with greater or less accuracy; and when the flame is so placed inside as to coincide with the image formed by the apparatus, rays will proceed from points in the image to corresponding points in the landscape, along the same paths which were followed by the rays which, starting from without, formed the image within: and different parts of the flame do in fact illuminate different parts of the sea and sky.

A photographic camera gives a good illustration of this fact. The lens can be so placed as to project an inverted image of a landscape on a glass screen. If a lamp is placed instead of the ground glass, its light will be seen through the lens from those places whose image corresponds with the position of the lamp, and from no other places. And, in like manner, the best and most brilliant light may be so placed within a lighthouse as to be invisible at sea, when the apparatus itself is well constructed.

A mariner, when he looks from a given position, through a dioptric apparatus of the first order, at a lighthouse lamp with four concentric wicks, is not looking at a single radiant point placed in the common focus of the instrument. His eye is affected by rays proceeding from a vast number of radiant points, variously situated, in different parts of eight different sources of light, of various forms and dimensions, and placed at different distances from the apparatus, some within and others beyond the focus for parallel rays. Each of these sources of light is viewed in many different directions through as many different pieces of glass; and every piece of glass, taken separately, is in itself a complicated optical instrument, with curves, angles, and a focus of its own, contrived by its inventor for a particular purpose, and to form part of a definite whole.

As a lighthouse flame is composed of many irregular figures, there are probably no two spots equally illuminated by a lighthouse beam.

When such is the complicated nature of the instrument, and when all its parts have been contrived and made for a particular purpose, any new adjustment or arrangement of

* See the table in Vol. I. The South Foreland light is omitted, as at the time of the inquiry the electric light was being burnt there.

these different parts, after they have been so made and put together, must be skilfully and scientifically done, if it is to be efficient.

It seems to follow, therefore, that the altitude as well as position of every new light-house, and the size and shape of the light to be placed in it, ought to be known and fully considered before the apparatus is made and put together.

A beam of a given divergence, with its axis in the plane of the geometrical horizon, or at right angles to a vertical line, must become invisible from the sea if the light is raised to a sufficient height above the earth whose surface is curved; and the more nearly it approaches that height the less serviceable will it be, because the greater will be the amount of light thrown on the sky.

It is found in practice that the fact agrees with the theory, and that much light is now wasted, especially in high lighthouses with low flames.

The experiments tried by our Secretary at the Point of Ayre (see Vol. I. p. 44), and at Bidston (see Vol. I. p. 61, and our observations made on the Gunfleet Light, Vol. I. p. 33) will show that catoptric lights, as at present constructed, do not fulfil perfectly the conditions required; that is to say, they throw only a portion of the light produced, on the sea, where it is wanted. On the contrary, a very large portion is thrown on the sky; and as the light at the Point of Ayre is revolving, and shows all round, it illuminates the highest hills in the Isle of Man, and great part of the light produced is wasted.

Present catoptric lights faulty.

Again, as regards dioptric lights, as at present used in England and Ireland, it has been found that great improvements are possible. A large portion of the light produced even in those which are best made is now wasted. In some cases a part of the light is thrown too high, in others it shines on the land. In some the fault appears to arise from a want of consideration of the requirements of the locality, in others from want of adjustment in apparatus ordered with insufficient specification by the Authority giving the order,—originally constructed by a manufacturer without reference to elevation,—and finally placed by the Authorities, without considering the construction, at an elevation for which it was not fitted. (See the Whitby Paper, Vol. I. p. 63; also p. 210, &c.) There are also cases of faulty manufacture, involving bad glass and inaccurate grinding.

Present dioptric lights faulty.

This is a good specimen of Commission's English.

These defects were early noticed by Your Commissioners, and we found them to exist in lighthouses abroad as well as at home, and one of our first acts on arriving at these conclusions was to frame the questions of Circulars IX. and X., and address them to such Scientific men as might be supposed capable of giving a valuable opinion, and to Manufacturers of Lighthouse apparatus.

But Your Majesty's Commissioners thought it highly desirable that the opinions which they had themselves formed, and those which they might elicit, should, if possible, be confirmed by the highest available authority.

Astronomer Royal.

We accordingly applied to the Astronomer Royal for his valuable aid; and we wish here to express our high sense of the kindness with which Professor Airy acceded to our wishes, and of the advantage which we have derived from his assistance. Our wish was that the Astronomer Royal, a high authority on mathematics and optics, should have the best opportunity of forming an opinion as to the adjustment of dioptric apparatus, and with that view he was informed of what had been observed by us; the specifications prepared by the Lighthouse Boards in ordering dioptric apparatus were also laid before him; and he was requested to accompany your Commissioners, and to inspect dioptric lighthouses at home and abroad.

Professor Airy readily complied with these requests; he gave his time and attention gratuitously; and the result of his personal observations, as stated by himself in his reports and letters to the Chairman, will be found in Vol. I. p. 77.

The first light visited by Your Majesty's Commissioners in company with the Astronomer Royal was the Start. An account of the proceedings will be found in Vol. I. p. 46, and our subsequent proceedings with reference to the adjustment of Illuminating apparatus are described on the pages which follow. These include special visits to the Forelands, St. Catherine's Head, the Needles, Ramsgate, and Shoreham, the French lights of Calais, Grisnez, and Ailly; meetings with Lighthouse Authorities, and other scientific men, at the North Foreland and Whitby; a visit by the Astronomer Royal to Girdleness, in Scotland, and another by Your Commissioners to Minehead and Dungarvon, in Ireland, and experiments at the works of Messrs. Chance, at Birmingham.

Start Lighthouse, &c.

The result of all these proceedings may be summed up in a few words:

1. The dip of the sea-horizon below the geometrical horizon has never, in the United Kingdom, been properly taken into account in dioptric lights, although where the light

Summary of defects.

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X is high above the surface of the sea, as for instance, 240 feet at Whitby, this makes the important difference of 0.16 inch in the proper position of the flame.*

2. The various pieces of which a dioptric illuminating apparatus is composed, have not even been adjusted to the flame and the geometrical horizon with sufficient accuracy. The result of this has usually been to send a most unnecessarily large amount of the rays upward to the sky, as may be easily determined for each individual piece of glass by the plan of internal observation devised by Mr. Campbell, the Secretary of the Commission.† Professor Holmes has stated that out of 96 prisms at the South Foreland light, which he examined from outside, he found 94 faulty in this respect.

Consumption of oil insufficient; wicks too few; lamps imperfect.

3. The flame in English and Irish lights is kept far too low, owing to the use of only three wicks and of the fountain lamp, which burns on an average only 474 gallons of oil annually in England, and 442 in Ireland. This has the double disadvantage of diminishing the upper part of the flame, which is of the greatest service in illuminating the sea, and of lowering the section of greatest luminosity in the flame below the focus of the lens, thus causing the brightest portion of the light to be in that portion of the same which always of necessity sends its rays above the horizon. (See Plates 1, 2, 3, at the end of Vol. I., and pp. 225, 226.)

This fault was not found to exist in the lights under the Northern Commissioners, who make use of a mechanical pump lamp, which burns on an average 794 gallons of oil annually, and produces good flames of about double the height of those in England or Ireland.

Other remarks on the want of reflectors on the land side of the apparatus, on the injurious effect of the shoulder of the lamp-glass, on the erroneous position of astragals, on the want of filters, medicine chests, clocks, signals for day, night, during fogs, &c., will be frequently found among the personal observations of your Commissioners, and in the special report on the Whitby Lights in Vol. I. p. 63.

The Elder Brethren of the Trinity House are now alive to the importance of these subjects, as far as relates to their works, and the scientific adviser to whom they apply in such cases, Professor Faraday, has now directed his attention to them; and Your Commissioners anticipate that the defects which have been pointed out will soon be remedied, now that attention has been called to them, and after their existence has been demonstrated by so many experiments and observations.

4th. *The distinction of one light from another.*

Distinction of lights.

Various means are resorted to to effect this important object. Some lights are fixed, others are revolving; some are white, others are coloured. The following tables, drawn up from the Admiralty lists of lights, will indicate the extent to which this distinguishing of lights is carried in the three countries:—

Character.

Country.	FIXED.		REVOLVING, FLASHING, INTERMITTENT.											
	No. of.	No. of.	Interval between maxima of brilliancy.											
			5 Seconds.	10 Seconds.	15 Seconds.	20 Seconds.	30 Seconds.	45 Seconds.	1 Minute.	1½ Minute.	2 Minutes.	3 Minutes.	4 Minutes.	
England—Trinity House	63	19	0	1	1	5	3	0	4	1	3	0	1	
„ Local	60	4	0	0	0	0	3	0	0	0	1	0	0	
Scotland—Northern Commissioners	23	23	3	2	1	0	3	0	7	0	5	2	0	
„ Local	60	3	0	0	0	0	0	0	3	0	0	0	0	
Ireland—Ballast Board	55	14	0	1	1	0	1	1	4	1	4	1	0	
„ Local	8	2	0	1	0	0	0	0	0	0	0	1	0	
Total	269	65	3	5	3	5	10	1	18	2	13	4	1	

Many of these distinctions again are susceptible of sub-division; for instance, some lights, designated "fixed and flashing," give a constant light, besides the waxing and waning light, with intervals of darkness, while others alternate between brilliancy and total darkness. Again, the relative duration of light and darkness may be different, although the intervals between the maxima of brilliancy may be the same.

* The flames maintained in the Scotch 1st order lighthouses appear to have their sections of maximum luminosity so high as in some cases to compensate for this neglect, so far as the lenses are concerned.
† It has since been ascertained that this plan was adopted by M. Fresnel in adjusting the mirrors above the lenses of his apparatus. See Vol. II. page 625, for a description of the method referred to above.

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The result of all these proceedings may be ^{P. 16 draft} ^{repar}
 summed up in a few words.

The display apparatus in the United Kingdom is not always arranged so as to be turned to the best advantage. In lights where the English and Irish authorities especially the amount of light produced is often deficient &c.

The apparatus itself is often so adjusted as to waste a great part of the light produced: and these defects can easily be remedied in a great degree by introducing better lamps burning more oil & adjusting the apparatus and adding reflectors where they are wanted

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	More red lights recommended.

at the house, or at the Index Map projected by our Secretary; but at the same time we consider that it is highly desirable wherever practicable to make red lights revolve, in order that the greater quantity of light thus brought into one direction may counteract the absorption of rays due to the coloured glass. Indeed, Your Commissioners would willingly see, as far as practicable, all lights in prominent situations revolving, since a greater range in dull weather is thus obtained, and there is less chance of mistaking them for ships' lights, which are now often of great brilliancy, or of mistaking ships' lights for them. At the same time it should be borne in mind that, at the rate at which ships are now propelled, it is desirable (in order to enable the mariner to secure a bearing) that some light beside the revolving light, particularly if it is a quick revolving light, should be visible throughout the whole revolution at as great a distance as possible.

Red and prominent white lights recommended to be made revolving.

Sometimes two lights, even on separate towers, are exhibited, in order to form a distinction from a neighbouring light. By this means the expense is very nearly doubled; and where distinction is the only object gained, it appears to show more prodigality than ingenuity. (See Vol. II. pp. 67, 252; and Vol. I. p. 70.)

Two separate towers objected to.

It is also desirable that a lighthouse should be a very visible object from the sea by day. Your Commissioners during their visits had frequent occasion to remark how little this had been considered, especially in Scotland, where the handsome stone towers unpainted could often be scarcely distinguished at a distance from the grey background. We recommend that the lighthouses should always be coloured so as to present the greatest contrast with the background, and that the buildings and walls attached to the towers should be kept carefully whitewashed where the ground is dark.

The colouring of lighthouses with reference to background recommended.

The distinction of lighthouses by day is susceptible of much development by the more extended use of coloured stripes or bands.

There is another important point connected with the quality of lighthouses, to which Your Commissioners have given attention, namely, the means of indicating the locality during fogs which the light cannot penetrate. This is sought to be effected by bells, and in one or two instances by guns; but it is rarely attempted at stationary lighthouses, except at those built on rocks in the sea, or on piles. We recommend the more frequent adoption of whatever means may be found most efficient. (See Vol. I. p. 225.)

Further use of fog-signals recommended.

Your Commissioners consider it desirable that Admiral FitzRoy's plan of notifying at the principal ports the approach and course of storms should be extended to certain of the lighthouses in prominent positions, for the purpose of such information being signalized thence to passing ships; and if the Astronomer Royal's proposition for exhibiting a time-ball at the Start should be carried out, such signals might be advantageously established at that point. Admiral FitzRoy has supplied various lighthouses in the United Kingdom with the necessary meteorological instruments. In several of the answers to Your Commissioners' scientific inquiries the same suggestion is touched upon. Had such a system existed when the Royal Charter was lost, that fearful wreck might possibly have been avoided.

The signalizing of storms from lighthouses recommended.

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Country.	White.	COLOURED.						Colour.
		White and Red.	Red.	Green.	Red and Green.	Red, White, and Green.	Blue.	
England—Trinity House - -	64	13	5	0	0	0	0	
„ Local - -	31	4	20	4	2	1	2	
Scotland—Northern Commissioners -	32	10	3	0	0	1	0	
„ Local - -	31	5	25	1	1	0	0	
Ireland—Ballast Board - -	49	16	3	0	0	1	0	
„ Local - -	4	3	3	0	0	0	0	
Total - - - -	211	51	59	5	3	3	2	

Of the coloured lights all are fixed, with the exception of 14 revolving lights, which show red and white alternately, and three simple red lights which revolve.

The use of coloured lights has this disadvantage, that the colour is only obtained by absorbing a large portion of the rays emitted from the lamp, namely those of other colours; and, therefore, the required intensity is only obtained by consuming a larger amount of oil. Again, green and blue lights are highly objectionable for lighthouses, except for very short ranges, on account of the readiness with which rays of those colours are absorbed by the atmosphere if it is at all misty. Red rays, on the contrary, penetrate peculiarly well; and, as Your Commissioners have witnessed, furnish an admirable and most useful means of distinction, one, which in their opinion is not enough resorted to,—a deficiency which will be at once apparent on a glance at the above table, especially in reference to the Trinity House, or at the Index Map projected by our Secretary; but at the same time we consider that it is highly desirable wherever practicable to make red lights revolve, in order that the greater quantity of light thus brought into one direction may counteract the absorption of rays due to the coloured glass. Indeed, Your Commissioners would willingly see, as far as practicable, all lights in prominent situations revolving, since a greater range in dull weather is thus obtained, and there is less chance of mistaking them for ships' lights, which are now often of great brilliancy, or of mistaking ships' lights for them. At the same time it should be borne in mind that, at the rate at which ships are now propelled, it is desirable (in order to enable the mariner to secure a bearing) that some light beside the revolving light, particularly if it is a quick revolving light, should be visible throughout the whole revolution at as great a distance as possible.

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The signalizing of storms from lighthouses recommended.

Quality compared with Foreign Lights.

Quality com-
pared with
other countries.

With reference to the *quality of the lights of the United Kingdom as compared with foreign lights*, the answers to Questions 4 and 5 of Circular VIII. show that the majority of the mariners who use them consider British lights generally to be at least equal to all others in the world, and that those of France rank next. Out of 586 who have replied to Question 4, "Do you think that the coasts of the United Kingdom are as well lighted as any of the foreign coasts which you have already named?"—514 consider the coasts of the United Kingdom as well lighted as any others with which they are acquainted, while in reply to Question 5, "If you think that the coasts of the United Kingdom are not so well lighted as those of any other country or countries, name those countries in the order in which you prefer their lights,"—out of 311, 200 express their preference of the British lights, and only 33 prefer those of any other country. Nor is this due to any patriotic prejudice in favour of England, for of the 34 masters of foreign vessels who have answered Question 4, 24 think England as well lighted as any other country they know; one is doubtful; but not one foreigner prefers the lighting of any foreign shore.

These comparisons by the 200 mariners who prefer British lights and the 33 who prefer those of some other country have, however, been more closely analysed; and it appears that out of the 200, only 42 profess to be well acquainted with the coasts of France, while it must be remembered there are 25 who express a preference for the French lighting. This weight of evidence, therefore, in favour of the United Kingdom as compared with France is not great. Many circumstances also must interfere with the accuracy of such comparisons; for instance, on the one hand an advantage is given to foreign countries by the greater clearness of the atmosphere, and, on the other hand, an advantage is given to Great Britain by its shores being the usual landfall of those mariners who have replied to the questions.

The testimony of the replies given to Question 7 of the same Circular, "What British and what foreign light have you usually seen furthest off, and which of the two has been usually visible at the greatest distance?"—is to a similar effect; but it refers only to the brightest lights; and an analysis of these replies gives several additional points of interest. Such an analysis is made in the tables in Vol. I. pp. 114–119, and the following are the principal results:—

579 witnesses have mentioned the 25 Lighthouses named in the table as the British lights which they have usually seen furthest off.

These have made 184 direct comparisons with the foreign lights which they have usually seen furthest off.

And, in reply to the question which of the two has been usually seen at the greatest distance—

112 witnesses are in favour of British lights.

72 " " Foreign lights.

Giving a majority in favour of British lights of 40 on 184 comparisons. 15 of the 25 British lights mentioned are preferred to the Foreign lights compared with them; 1 is equal; 9 are inferior; giving a majority of 6 in favour of British lights. Of the 15 British lights preferred, 9 are catoptric revolving or flashing, 2 catoptric fixed; 2 dioptric fixed, 2 dioptric revolving.

Nine British lights are said to be inferior to those Foreign lights compared with them. Of these British lights 3 are dioptric fixed, 2 dioptric revolving or flashing; 2 catoptric fixed, 2 catoptric revolving.

This large preponderance of evidence in favour of the catoptric revolving over the dioptric revolving, as hitherto exhibited in England and Ireland, and which is further confirmed by the table in Vol. I. p. 117, fully confirms the remarks made, and the reason of it and the remedy are there given.

Dioptric revolving lights ought to be very powerful. Of the two which are considered inferior to the Foreign lights compared with them, the Start is one, and the condition of that light, which is described by us in Vol. I. p. 46, will show the value of these comparisons made from observation at sea by the men most interested in the lights. The other inferior dioptric revolving light is Ballycottin. It appears from the reply to Question 38, Circular III., that the annual consumption of oil is 354 gallons, as against the Start 498, the South Foreland 511, Skerry Vore 781, Kinnaird Head 800, while at Grisnez it is stated to be 785, all of which are dioptric, 1st class. And this again shows the correctness of the comparisons, for the oil burned is a measure of the light produced.

Again, of all the Foreign lights mentioned and compared, Grisnez (probably from its prominent position) is most frequently named. It is mentioned as seen at great distances

by 108 witnesses ; but of the 12 British lights compared with it 7 are said to be better, 5 worse ; and of 48 comparisons between it and British lights 30 are in favour of the latter.

The above evidence then goes to show that the quality of British lights (speaking generally) is equal to the quality of lights in any part of the world ; and the testimony is especially valuable because the men who give it are mariners, those best able to judge of the appearance of the light ; and, as appears from their evidence elsewhere, generally knowing nothing about the manner in which the light is produced. As one witness remarks " They don't know the ropes," C. and D., (catoptric and dioptric,) but most of them think that first-class British lights, speaking generally, are as good as most first-class lights which they have seen abroad, and better than many.

Your Majesty's Commissioners have no reason to differ from this general opinion ; but in subscribing to it, we think it necessary to revert again to the various defects that we have ascertained to exist in the present dioptric lights, especially of England and Ireland, and to the experiments, observations, and reports that have been made by us or at our instance on the matter. There are, indeed, many particulars in which the quality of British lights might be greatly improved. (See Vol. I. p. 63.)

There was a time when the shores of this kingdom were unquestionably much better lit than those of other countries. At that time silvered parabolic reflectors with Argand lamps were considered to be the best of optical apparatus for lighthouses, and they were largely used and are still retained in very many situations by the General Lighthouse Authorities. Amongst Local Authorities, smoky lamps, candles, and tin reflectors, some even painted in front, may even now be found. (See Dover, Vol. II. page 305.)

There are indeed many situations in which reflectors properly kept are supposed by the Lighthouse Authorities to be as useful as lenses ; and the great labour, care, and skill bestowed by the keepers on the cleaning of the reflectors assist in making some British catoptric revolving lights compare favourably with the best lens lights in France. In catoptric revolving lights, the number of lamps and reflectors on one face can be multiplied so as to increase the power. Beachy Head, for example, is a catoptric revolving light, showing ten reflectors on one face, and is favourably compared with Grisnez, which is a dioptric flashing light, though Grisnez is some feet higher than Beachy Head. There is but one lamp at Grisnez, burning, according to regulation, 785 gallons ; at Beachy Head there are thirty lamps, burning about 1,000 gallons of oil in a year.

The fixed catoptric lights of the British Isles are never mentioned by any mariner as having been seen at a great distance, and, indeed, with the exception of the Lizard, their names scarcely occur among the answers to Question 7. There can be no doubt that they will not bear comparison with revolving lights on the same principle, or with the dioptric lights of France or Scotland. As to the fixed catoptric lights abroad (there are scarcely any in France) not one of them seems to be named, except that on Heligoland, which belongs to the Trinity House.

Quality compared with other countries.

On comparing the *quality* of British lights with those of foreign countries in the four particulars mentioned above, it may be remarked :—

Particulars of comparison.

1st. With reference to the source of light, the observations of the Commissioners have placed it beyond doubt that the French have the advantage over the English and Irish in the height and brilliancy of their flames, owing mainly to their use of the mechanical lamp. (See Plate I at the end of Vol. I.)

2nd. As to the optical apparatus, the dioptric system, invented and first employed in France, has been gradually adopted in our own country, and in Scotland some improvements have been made in it. There is, however, this important difference : in France the new apparatus was adopted throughout the whole Lighthouse service ; and in the United States, and in Spain, it has been lately exclusively adopted in the great reformation of their Lighthouse system just effected by the Governments of those countries ; but in the United Kingdom the old reflectors have only been replaced from time to time by the refracting apparatus ; and the Board of Trade now lay down the principle, that the expense should only be incurred when the reflectors are worn out. It still remains an open question in some minds whether the change should at once be completed along the whole shores of Britain, and in other minds whether the purely catoptric principle is not better than the purely dioptric under certain circumstances ; but few will doubt that a combination of the two would often be the most efficient, and such combinations exist in all countries, but especially in Scotland. Your Commissioners, indeed, are prepared to recommend a more rapid substitution of these catadioptric arrangements for the simple metallic reflectors now in use at so many situations, and we deem this especially requisite when the light is a fixed one. If the electric light come into general use, it may necessitate some important modifications of the existing apparatus.

Substitution of catadioptric for catoptric apparatus recommended.

3rd. As the dioptric apparatus used in England has been obtained from France till very recently, or constructed on French models, it can be no matter of astonishment that Your Commissioners found in that country the same errors of adjustment between the optical pieces and the lamp, which they had first remarked at home; but these errors were greatly aggravated in England and Ireland, where the flame was low. The excellence of the light at Grisnez was found to be due partly to the height of the flame of the mechanical lamp, but partly also to the fact that the old-fashioned mirrors had been well adjusted to the sea-horizon after erection,—a point that cannot be so easily secured in apparatus of more modern construction (such as is used at Calais), where the totally reflecting prisms are secured in their places before the apparatus leaves the manufactory, and without reference to the altitude of the proposed situation. There was, however, but very slight fault to be found with the adjustment of the Illuminating apparatus at Ailly. (See Vol. I. p. 59, and the Astronomer Royal's Report, p. 85.)

4th. In regard to the distinction of one light from another by varying its character the French, according to the Admiralty lists, do not avail themselves so much as the English of the various means, and the Americans seem to be inferior; but in Spain and Brazil the proportion of revolving to fixed lights is much greater, and red flashes are more frequently employed than in the United Kingdom.

The United States Authorities pay more attention to the distinction of lighthouses by day, by means of colour, than the Authorities in this country.

The French use silk webs in the wicks; and filter the oil that has flowed through the burners before returning it to the lamp for another night's consumption.

An account of a bell with a reflector, on Boulogne pier, used in foggy weather, with evidence as to the extent to which it answers its purpose, will be found in Vol. I. p. 221.

EXPENSE OF CONSTRUCTION AND MAINTENANCE.

Expense of
construction.

The *expense of constructing* a lighthouse depends so much on the requisite height of the tower, the accessibility of the site, the facility of procuring material or workmen, and many other circumstances varying with the locality or the character of the work, that it is difficult to form a comparison between the practice of different boards in this respect; yet there are some points which appear worthy of remark.

The triumphs of Lighthouse engineering are those towers which rise in the midst of an open sea on small isolated rocks or reefs that are washed over by the waves. The Eddystone was the first of this class, but it has been exceeded in magnitude, and in the difficulties overcome in the construction, by three more recent erections, the heights and total cost of each of which are given below:—

Bell Rock, Scotland, East Coast; height, 117 feet; cost,	61,331 <i>l.</i>	9 <i>s.</i>	2 <i>d.</i>
Skerry Vore, „ West Coast; „ 158 „ „	83,126 <i>l.</i>	12 <i>s.</i>	1 <i>d.</i>
Bishop Rock, England, Scilly Isles; „ 145 „ „	36,559 <i>l.</i>	18 <i>s.</i>	9 <i>d.</i>

The two last are, to a certain extent, comparable works, both being erected on rocks almost covered by the sea at high water, both far from land, and exposed to the force of the Atlantic, and both more or less on the model of the Eddystone; yet the Bishop which is nearly as tall as the Skerry Vore, cost in construction less than half what was expended on that magnificent work. It must be remembered, however, that at Skerry Vore the workmen, the materials, and all the requisite stores, had to be conveyed a distance five times as great as at Scilly which in that stormy region rendered the chances of landing much more precarious, and that a quarry and a harbour had to be formed; circumstances which involved a large expense that cannot be estimated with any precision.

Again, in Scotland, there are a number of modern Lighthouses on the mainland, as at Girdleness, Buchanness, Covesea Skerries, and Ardnamurchan, handsome towers from 115 to 120 feet in height, with substantial edifices for keepers around their base, and these have cost 10,000*l.* or 11,000*l.* for the building alone. The only Lighthouse on the mainland in England equalling them in height, and fairly comparable is that at St. Catharine's Head, in the Isle of Wight, which cost 7,673*l.* 17*s.* 2*d.* It also is of stone. The Irish Lighthouse at Kinsale, 100 feet high, is somewhat comparable with these Scotch erections, and cost about 9,000*l.*

The usual Lighthouses on the mainland of England, or on rocky islands, built by the Trinity House, are much smaller erections, often costing no more than from 3,000*l.* to 5,000*l.*, and rarely exceeding 7,500*l.*

The average cost of a Lighthouse on the mainland, or on rocky islands, in Scotland, is about 8,000*l.*

In general the Irish Lighthouses, even on the mainland, have been erected at an expense of 10,000*l.*, but this includes the Illuminating apparatus, and in some instances the formation of a road.

The only complaints which the Commissioners have heard respecting the cost of erection of Lighthouses have been with reference to the Scotch, and have proceeded from the Board of Trade. (See Oral Evidence, answer 928.) The structures erected during this century in that country are doubtless most substantially built, generally of granite, and of great height; there seems to be very little outlay on mere ornament, and they present a noble appearance as public works; but when the great difference in cost between them and English Lighthouses designed to serve a similar purpose is considered, there can be little doubt either that the Scotch and Irish Authorities have not paid due regard to economy, or that the English Authorities, keeping economy too closely in view, have not erected edifices worthy of themselves and of the nation; unless, indeed, there be some circumstances which render similar erections necessarily more costly in Scotland and Ireland.

If it is difficult to compare justly the *cost of construction* between the different portions of the United Kingdom, it is still more difficult to draw a comparison with the expense incurred in countries where labour is very differently remunerated, and where the Management of Lighthouses is centralized in the National Government. Yet some interesting data for such a comparison have been obtained.

Expense of construction compared with foreign countries.

On turning to France we arrive at some startling results,—The Phare de Bréhat, on the north-west coast of France, stands on a rock at sea like the Skerry Vore or the Bishop Rock, but more under high water than they are; it is built of granite, and equals the Skerry Vore tower in height, at least within a foot or two, yet the total expense, including that of the 1st order dioptric apparatus, is stated to have been only 23,120*l.* The payments to the Government engineers, the transport of material by Government vessels, and some other matters, are probably not included; and other circumstances, including exposure to storms, were more favourable, thus rendering the comparison of little value, yet the smallness of the sum is striking.

Again, the French have built at Calais a tower of brick and calcareous stone, handsomely fitted up within, as is the case generally with 1st order French lights, 167 feet high, and therefore taller than any lighthouse tower in the British Isles, and half as tall again as the Scotch towers in analogous situations, which cost 10,000*l.* or 11,000*l.*, but the Calais Lighthouse was completed for 7,479*l.* The Harbour Lights in France, though differing greatly from one another, as might be expected, are said to cost on an average 320*l.* for their erection. In the British Isles Harbour Lights are generally under Local Authorities, and they differ more widely still, in fact from a common gas lamp post to lighthouses of large pretensions as the 1st order catadioptric light at Hartlepool; yet there are some in each division of the United Kingdom which have cost about the same as the French average; for instance, at Penzance in England, at Peterhead in Scotland, and at Cork in Ireland. Some buildings have cost less, but the majority have had a larger sum expended on their erection than the French.

The average expense of construction of four Spanish Lighthouses of the first order, height not stated, is only 5,450*l.*, including everything, and not one of those buildings, particulars of which have been kindly furnished by Señor Lucio del Valle, cost more than 7,611*l.* Their Lighthouses for Harbours appear to be more expensive than the French.

The American first-class light, described in the Return from the United States, cost 8,600*l.*

The Dutch have constructed a stone lighthouse on the coast at West Schouwen of the great height of 166 feet, only one foot less than that at Calais, with brick houses for the keepers, which, including the 1st order revolving apparatus, cost only 6,400*l.*

The Danish Government, on the other hand, has paid 10,673*l.* for a burnt brick and granite lighthouse, including the illuminating apparatus, at Skagen.

The lighthouse at the "Hohe Weg," Bremen, built of freestone, brick, and clinkers, cost, including the illuminating apparatus, 10,996*l.*

The Norwegian Government built the lighthouse at Little Færder for 7,500*l.*, and the iron one at Rundö, which is 110 feet high, for 10,800*l.*

In comparing these sums with those mentioned previously as expended in Great Britain, it must be borne in mind where a 1st order dioptric apparatus is included, that it costs from 1,500*l.* to 2,000*l.*

On the whole, therefore, the outlay of Foreign Governments in the construction of Lighthouses, making every allowance for the advantages which a more centralized system gives in such a comparison, appears to be rather greater than the outlay incurred by the English Board.

*Expense of Maintenance.*Expense of
maintenance.

The expense of maintenance of a light depends to a great extent on its class. It would be futile to attempt a comparison by taking the whole amount expended on lighting the coasts by each General Authority, or by each different country, and dividing that by the number of lights, unless it were ascertained that the different classes were in the same proportion, and that all expenses of lightships or buoys were excluded. The returns asked for by Your Commissioners tell the annual cost of each Lighthouse in 1858, under several distinct heads, and from these returns has been drawn up the following table of averages, which refers only to 1st order dioptric lights, or catoptric lights of the largest description:—

Country.	Oil.	Wicks.	Keepers' Salaries.	Repairs of Building.	Repairs of Apparatus.	Painting.	Total Expenditure (as returned).
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
England—Dioptric	76 18 0	1 14 2	126 10 9 2 suits of clothes, coals, &c.	29 6 2	13 2 4	24 2 8	265 5 1
„ Catoptric	127 6 2	1 6 5	141 8 4 2 suits of clothes, coals, &c.	30 8 0	15 0 6	21 1 8	340 5 0
Scotland—Dioptric	133 3 2	1 1 0	116 15 7 and land.	1 8 8	8 13 0	2 0 0	380 9 6
„ Catoptric	136 5 0	2 13 6	109 13 1 and land.	2 13 3	8 6 4	2 1 4	385 12 7
Ireland—Dioptric -	75 10 0	2 5 0	119 17 5	3 6 11	7 19 4	34 5 6	405 9 5
„ Catoptric -	140 9 0	2 4 9	110 15 4	9 11 2	23 5 7	44 5 1	485 11 3

Scotch method
of consuming
oil commended.

From this it is evident at a glance that as the Scotch dioptric lights burn a larger amount of oil than the English or Irish, they are more expensive in that item; but in this particular, expense becomes a measure of efficiency. The Scotch effect a saving in oil, amounting to about 1,300*l.* per annum, by lighting and extinguishing their lamps not at sunset and sunrise, but at the going away and reappearance of daylight, periods calculated separately and tabulated according to the latitude of each station. The amount burnt in the large catoptric lights of each country is about the same, oil being 1*d.* or 2*d.* per gallon cheaper in England than in Scotland or Ireland. Repairs of building is a larger item in the English than in the other Lighthouses, as they are usually older constructions, and of a less substantial character. The Scotch towers are generally not painted. As to the total expenditure, there is evidently a discrepancy in the manner in which it has been returned by the different Authorities, the Northern Commissioners and the Ballast Board having included items not included by the Trinity House, thus showing a greater discrepancy than exactness would warrant.

Besides the expenditure incurred in the individual Lighthouses, there are the general expenses of the Authority having charge of them. This is an important subject of inquiry, but will be better treated of under the head of “System of Management.”

The following table will afford the means of comparing the expense of maintenance of a first order dioptric light in foreign countries with that incurred in England, Scotland, and Ireland:—

Expense of
maintenance
compared with
foreign coun-
tries.

Country.	Lighthouse.	Total Expenditure.
		£ s. d.
France	Bréhat (Rock)	415 0 0
„	Mainland lights ;	
	average of four	320 0 0
Spain	Average	340 0 0
Denmark	Skagen	274 17 11

The French Government pays the keepers much less than is paid by any of the General Authorities in the United Kingdom, but its outlay in oil is very properly greater than in England or Ireland. The United States, on the contrary, pay as much as 275*l.* in keepers' salaries for a first-order Lighthouse, whilst the Trinity House, as shown in the preceding table, pays on an average 126*l.* 10*s.* 9*d.*

FLOATING LIGHTS.

The number of Floating Lights in position in the United Kingdom is 47.

They are thus distributed—

Number.

Country.	Floating Lights in position.	Floating Lights in reserve.
England—Trinity House - -	34	4
„ Local Authorities - -	7	3
Scotland—Northern Commissioners	—	—
„ Local Authorities - -	1	—
Ireland—Ballast Board - -	4	1
„ Local Authorities - -	1	—
Total	47	8

Of the Floating Lights under the Local Authorities, Liverpool has three and Hull two; there is one in the Solway, and another in the Tees; one in the Clyde, and the remaining one in Lough Foyle.

The Index Map shows the positions of these vessels. They appear to have been chosen with good judgment, for very few complaints are made in the evidence of the mariners. Position.

It can hardly be said that the Floating Lights even of England were sufficient when the Commission commenced its sittings, but the Trinity House is extending its mode of action in this respect, having placed two new vessels during the past year, the one in Cardigan Bay, the other on the Varne Shoal in the Channel. Additional Floating Lights are still suggested in the Mariners' Evidence, especially one to mark the Inner or Outer Dowsing, and we learn that the Trinity House have just obtained permission to place one there. Sufficiency

The question of their sufficiency depends also in some measure on the solution of a problem, which Mr. Herbert of the Trinity House proposes to make the subject of experiments on a large scale.

It has been proposed by him to extend the principle of lighting by establishing Floating Lights in the Fairway—the hulls to be constructed on the principle of his buoys, and the light the best known. (For description and drawing, see Vol. II. p. 618.)

The evidence which the Commissioners have obtained from the Masters of Light-vessels goes to prove that the most exposed situations are not necessarily the most dangerous or disagreeable. The Masters of the Seven Stones and Coningbeg Lightvessels agreed in saying, that the long sea, and great length of chain required to anchor in deep water, made their stations, which are the most exposed in the kingdom, easier to ride in than stations where the sea is shorter, the water shallower, and the current stronger; such as at Arklow, the Owers, and Cockle; and the Master of the Lightvessel in the Humber, who had crossed the Atlantic 60 times, said that he had never met with so “nasty” a sea as in the River Humber.

This, which at first sight appears strange, is explained by the fact, that when the wind is strong and its direction across a strong tide, a vessel often rides broadside to the sea. In the open sea the tides are not so strong, and the waves are longer.

The Lightvessel at the Goodwin was seen by the Commissioners so riding, to windward of her moorings, broadside to the sea, and rolling heavily.

The efficiency of a Floating Light depends on the attention paid to the four points dwelt on in reference to the quality of Lights on shore (see page 6), with one very important addition, namely, that it should remain on its station in all weathers. Quality.

The best proof that the lights are efficient in the last particular is to be found in the statements of the Lighthouse Authorities, which are fully confirmed by the evidence of mariners. The Lightvessels very seldom go adrift, and there is no instance on record in which the crew have voluntarily run from their stations in bad weather. When they have been driven from their moorings, the vessels have always been replaced in a very short time, and none have ever been wrecked. The Mariners' Evidence on this point is valuable, because the rare instances in which Lightvessels have been off their stations are repeatedly mentioned by independent witnesses as remarkable events. It does not appear that the lights have ever been accidentally extinguished.

Much has to be learned about the best form for resisting the force of winds and waves when the vessel is always at anchor. The shape of the hull now varies considerably. Some are longer than others. The part of the vessel to which the moorings are attached, and the points where the chains enter, are different. The Irish vessels are Form of light vessel.

generally longer and sharper than those in England, and set an after-sail when its use enables them to ride more easily. We have endeavoured to obtain evidence on these points, and have received many valuable opinions in reply to our questions on flotation. The testimony of the men on board has been in favour of considerable length, fine entrance, and a low point for attaching the moorings; but we would recommend this branch of scientific inquiry to the attentive consideration of those who have to decide the question practically, as these questions materially affect the steadiness of the light, security of ship, and safety and comfort of the men.

The source of light in lightships is invariably the combustion of oil. Mechanical or large lamps are not employed.

The apparatus by which the light is directed to where it is needed, consist of silvered reflectors and Argand lamps. In three instances only has the dioptric system been adopted in lightships, one of them being the local floating light of Stockton-on-Tees.

The reflectors are also smaller afloat; and with one or two exceptions only one reflector is shown on each face, and can be seen at once. The silver is much more liable to injury, and the reflectors were generally found to be in a less brilliant condition than any that were seen on shore; though in some of the vessels the reflectors were quite as well polished as any seen. Reflectors also wear out much sooner at sea.

It is a question for consideration, whether the dioptric principle might not be more generally introduced into floating lights; and whether some of the improved methods of producing light might not be adopted afloat. The science of illumination, as regards floating lights, requires development, especially as ships' lights are now made so brilliant.

The existing distinctions in Floating Lights are given in the subjoined table, as far as our returns indicate.

Distinction.	Country.	Total Number.	Number of Lights.			Character.			Colour.		
			1 Light.	2 Lights.	3 Lights.	Fixed.	Revolving.	Fixed and Revolving.	White.	Red.	Red and White.
	England—T. H. -	33	20	11	2	19	3	1	9	2	2
	„ Local -	7	6	1	—	7	—	—	6	1	—
	Scotland -	—	—	—	—	—	—	—	—	—	—
	„ Local -	—	—	—	—	—	—	—	—	—	—
	Ireland—B. B. -	4	1	2	1	3	—	1	4	—	—
	„ Local -	1	1	—	—	1	—	—	1	—	—
	Total	45	28	14	3	30	13	2	40	3	2

In regard to the distinction of the light of one lightship from another, or from shore lights, or from the lights of moving vessels, Your Commissioners cannot help thinking that red might be more frequently used, provided the revolving dioptric apparatus is adopted, and that a larger proportion might advantageously be made to revolve, provided the rapidity of revolution be sufficient to prevent the long extinction of the light.

Another point is the colour and distinguishing mark of floating lights by day; for it is important to every mariner to be enabled to recognize a particular lightvessel at a glance.

The Trinity House Lightvessels are painted red. In Ireland they are black with a white streak. At Liverpool, two are red and one black; and they are all distinguished by balls hoisted at the mastheads, and by other signals, and some have their names painted on their sides. Black and red seem to be the colours which contrast best with the colour of the sea, and they are in fact best seen.

Gongs are used as fog-signals in the lightvessels of the Trinity House and Ballast Board; but Your Commissioners are satisfied that they are not sufficiently powerful, and recommend the provision of a more efficient warning in fog as a subject of investigation and experiment.

Expense of Construction and Maintenance.

The average cost of a lightvessel when fully equipped, exclusive of stores, is as follows:—

	£	s.	d.
England—Trinity House	3,622	12	7
„ Liverpool	4,547	0	0
„ Hull (small)	2,436	0	0
Ireland—Ballast Board	6,224	11	9

The Return from Liverpool does not include the cost of the Crosby Channel Floating Light. One of the two vessels belonging to Hull, viz., the Hebbles, is very small.

Improved illuminating apparatus recommended.

Red revolving lights recommended.

Improved fog signals recommended.

Expense of construction.

The Floating Lights in Ireland are of a larger size and better character than the average of those in England.

The average annual expense of maintaining a Floating Light in the United Kingdom is as follows:—

Expense of maintenance.

Country.	Ordinary Repairs and Painting.	Expense of Oil.	Wages.	Victualling Allowances.	Total Expenditure in 1858 (as returned).
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
England—Trinity House	70 8 5	59 7 8	430 19 2 11 suits of uniform.	301 2 6	1,103 18 1
„ Liverpool	450 0 0	103 13 4	450 13 4	408 12 0	1,464 11 3
„ Hull	40 6 2	38 14 9	284 5 0	219 8 9	—
Ireland—Ballast Board	586 4 9	90 6 8	423 18 0	256 12 9	1,320 15 11

The Floating Lights of the Trinity House are brought into harbour to be repaired from time to time, and this is not reckoned among the ordinary repairs and painting, hence the smallness of the sum in the first column of the above table. In the total expenditure this seems to be included.

There is little room for comparison between the Floating Lights in England and those of any other country. France has only two, and Spain has not established any. The United States are better provided, having 48, but they were confessedly in a very inefficient condition till recently, when those of England were copied, possibly with some improvements. Their vessels are painted in stripes and bands, and of various colours, so as to be recognized at once.

Comparison with foreign countries.

It is stated in America that the vessels used frequently to leave their stations and run into harbour in heavy weather; indeed, that is admitted in the return forwarded by the United States Government.

The following table gives the cost of a Lightvessel when complete for service, and the annual expense of maintenance in several foreign countries:—

Country.	Name of Vessel.	Cost of Vessel.	Cost of Maintenance.
		£ s. d.	£ s. d.
United States	“ Nantucket, New South Shoals ”	About 4,375 0 0	About 1,354 0 0
Sweden	“ Fingrundet ”	3,500 0 0	—
Hamburg	Average of Three	3,500 0 0	740 0 0
Bremen	“ Bremen ”	2,564 0 0	685 0 0
Denmark	“ Kobbergrundten ”	5,606 4 3	—
Belgium	“ Paarde Markt ”	2,968 10 0	—
Holland	“ Noord Hinder ”	3,100 0 0	—

Further details are to be found in the Returns.

It is evident that whether at home or abroad it is far more costly to maintain a Light afloat than on shore, and where the Light itself cannot be made perfectly stationary, a refined adjustment of the illuminating apparatus to the horizon would be injurious. Where practicable, therefore, stationary buildings should be erected, such as the Screw-pile Lighthouses at the mouth of the Thames, and elsewhere.

BUOYS.

The number of Buoys in the United Kingdom, as far as can be ascertained from the Returns, is as follows; but as there are many Local Authorities which have given no information, the number must be defective in this respect. Wreck Buoys and Warping Buoys are excluded from the Returns.

Number

Country.	Buoys in position.	Buoys in reserve.
England—Trinity House	356	458
„ Admiralty	65	—
„ Local Authorities	375	—
Scotland—Northern Commissioners	92	79
„ Local Authorities	64	—
Ireland—Ballast Board	53	56
„ Local Authorities	104	—
Total	1,109	573

Position.

The *position* of these buoys is marked in the charts, which have been furnished by the several Authorities, but it was not thought necessary to publish these. The position of the buoys are marked on the Admiralty Charts.

Very few alterations are suggested in the positions of existing buoys by those who have answered the Circulars addressed to Mariners and to Lloyd's Agents; and, on the whole, there does not seem to be ground for dissatisfaction in respect to *position*.

Sufficiency.

The number of buoys in some districts appears to be amply sufficient. In other districts there are hardly any, and in others more are wanted. The Replies of Mariners to Question 23 show in detail where the witnesses desire that buoys should be placed, and similar evidence is given by Lloyd's Agents, who frequently speak of the want of buoys in certain localities, especially in Scotland and Ireland.

Some instances of neglect have come to the knowledge of the Commissioners; as at Limerick, where the buoys have gradually disappeared, and never been replaced, though there were ample funds expressly for the purpose.

Sufficiency compared with foreign countries.

That the coasts of the United Kingdom are better supplied with buoys than any foreign coasts is borne out by the almost unanimous opinions expressed by the 488 persons who follow the sea, who have answered Question 14 of Circular VIII.

Quality.

The prime requisites in a buoy are that it should be conspicuous, distinctive, and permanent.

It appears from the Returns, however, that buoys are liable to various accidents, especially that of being fouled or run down by ships. Of the 356 Trinity House buoys in position, only 14 broke adrift in 1858; none of the egg-bottomed or flat-bottomed buoys were so displaced in that year. Of the 92 buoys belonging to the Northern Commissioners, 2 only broke adrift in 1858; and of the 53 buoys under the Ballast Board, only the same number; while of the 608 buoys under local authorities a somewhat larger proportion, namely 35, broke adrift, though these latter generally ride in much less exposed situations.

Some buoys, for instance those under the Admiralty in the fairway leading into Portsmouth Harbour, disappear under water as soon as the tide becomes strong, and only reappear at slack water (see Vol. I.). Generally speaking, the buoys in use are not constructed on scientific principles; but there are others, either used or designed, which show more thought. Herbert's buoys have been tried on a large scale at Liverpool, in Ireland, and in England, and appear, when properly constructed, to be excellent. Lenox's, Poulter's, and Peacock's buoys, and many other forms, appear also to ride successfully; and in the Clyde there are large iron buoys of peculiar construction, which are commended.

The best form for a conspicuous floating body, to be permanently anchored at a particular spot, and the best method of securing it, have yet to be decided.

We have also asked and obtained the evidence of scientific men on this point, and would specially recommend the subject to the Authorities who have to deal practically with it.

Another and a very important inquiry as to the efficiency of buoyage is the system on which channels and harbours are buoyed, and whether, indeed, any system is adopted. Till lately there was no attempt at uniformity in any part of the British Isles, but the Northern Commissioners adopted a system, the main feature of which is placing red buoys on the starboard hand in entering the harbour, and black on the port hand. The Irish Board have frequently adopted a system too, but it is exactly the reverse of the Scotch; and only last year the Trinity House have decided to buoy channels uniformly, but on a totally different plan; namely, red or black buoys to starboard, and chequered to port, but they do not contemplate applying it to channels already buoyed. The Board of Trade has required that Lough Swilly in Ireland should be buoyed on this system. In the meantime some of the Local Authorities, as those at Liverpool and the Clyde, have adopted systems of their own, which may or may not be the same as that of the General Authority in the same country; the Admiralty have no uniform system.

Uniform system of buoyage recommended with dark colours.

Your Majesty's Commissioners recommend that some national system be introduced into the United Kingdom, and that the colours adopted in it should be dark. In support of this we would again call attention to the Mariners' Evidence. Of 268 mariners who have replied to Question 28, 148 are in favour of a uniform system, and a very large majority of those who have replied to Question 17, prefer black and red for colours, and angular forms, as being the most visible on the sea. The disadvantage of white under such circumstances has been frequently illustrated. (See Vols. I. and II.) Attention is directed to various proposed systems of buoyage, which will be found in Vol. I.

Quality compared with foreign countries.

The buoys in foreign countries do not appear to equal those of the British Isles either in size or general efficiency; but the adoption of a national system of buoyage, as in France, is evidently an advantage. The French contemplate improving their buoyage, and we saw a very large Herbert's Bell buoy in construction.

The original cost of a buoy varies greatly with its character and size. The Trinity House generally employ Can buoys costing from 27*l.* to 36*l.*, but it has many of a better kind costing 58*l.*, 130*l.*, and even 197*l.*, when complete. The Ballast Board makes most use of a buoy costing 26*l.*, but those costing 42*l.* 10*s.* or 62*l.* are not infrequent, and their largest Herbert's buoy cost 99*l.* 4*s.* The Northern Commissioners, on the other hand, do not employ any other than the old Nun and Can buoys, costing from 16*l.* 16*s.* to 31*l.* 10*s.*

Expense of construction.

The repairs required by a buoy arise mainly from accidents. Painting, however, is a regular expense, costing annually from 2*l.* 10*s.* to 5*l.* 5*s.* each in Ireland; 7*s.* 6*d.* in Scotland; and the mere expense of the paint in England, as it is done by the crews of Floating Lights when off duty.

Expense of maintenance.

The United States Government commonly use Nun and Can buoys, costing from 40*l.* to 100*l.* The Spanish obtains its buoys from England.

Cost compared with foreign countries.

BEACONS.

It is impossible to determine the number of Beacons in the British Isles, for the word itself is somewhat indefinite, particularly in the Local Returns, where they cannot be rigidly distinguished from other small leading marks. The following numbers all refer to structures of some magnitude:—

Number.

England—Trinity House	-	-	67
„ Admiralty	-	-	7
„ Channel Islands	-	-	19
Scotland—Northern Commissioners			33
„ Clyde	-	-	82
Ireland—Ballast Board	-	-	53

The *positions* of these and other beacons are given in the Admiralty Charts.

They appear to be fully *sufficient* in some places, but *deficient* in others. The positions where more beacons are wanted are mentioned in the Replies to Question 23 of Mariners' Evidence, and in the Evidence collected through Lloyd's Agents.

Position.
Sufficiency.

In rivers and estuaries in the United Kingdom and elsewhere, beacons are commonly sticks, or beams of wood planted in the mud, or fixed to rocks. Sometimes a beacon is a pile of stones, but there are also beacons of solid masonry, and structures of iron solidly fixed in places where such marks have been thought sufficient, and a light was not thought necessary. There is a beacon on a rock near Stornaway, which reflects light directed upon it from a lighthouse on shore. Hollow pile beacons have been erected on some shoals, as on the Goodwin Sands, and might advantageously be substituted in other places for buoys, just as permanent pile lighthouses are being in some places substituted for floating lights.

Quality.

Pile beacons commended.

The beaconage of the United Kingdom, like the buoyage, is on no uniform system of colour, or form, or construction; and generally nothing but local knowledge enables a mariner to tell his position by the beacons alone. The navigation of the Clyde is much facilitated by beacons solidly built at short distances from one another, and marked both by colour and by other indications, so as to show on which side of them is the channel. What is there effected might be attempted with advantage in other places under other jurisdictions.

Uniform system of colouring beacons commended.

Speaking generally, the beaconage of the United Kingdom admits of great improvement. The number might be increased, and the quality improved, and the efficiency of the service advanced.

The expense of erecting a beacon depends of course wholly on the nature of the construction and of the site. The cost varies from that of the beacon on the Wolf Rock, off the Land's End, amounting to 11,298*l.*, to that of "Jack-in-the-Basket," at the entrance of Lymington Creek, a mere pole painted white, with a basket at its top. The Pabba Beacon, in the Sound of Skye, the latest erected in Scotland, is of malleable iron, 40 feet in height, and cost 502*l.* 5*s.* 2*d.* The expense of maintenance is in many cases nil, and never should be much, unless in situations where the nature of the position is such that damage is frequently being caused by the almost irresistible force of the sea.

Expense of construction and maintenance.

The beacons which your Commissioners have seen abroad, and those described in the Returns from foreign countries, do not seem to be better than those of the United Kingdom, except in so far as there is a national system.

Comparison with foreign countries.

In France the beacons and buoys are coloured on the same plan, and even patches of rocks on different sides of channels are (according to the Returns) painted black and red.

In Sweden, the trees which are planted in the water, on one side of a channel, have a bunch of branches at the top, and those on the other side are left bare, and the principle of indicating compass bearings of shoals is acted on.

SYSTEM OF GOVERNMENT.

The system of management and control under which Lights, Buoys, and Beacons are constructed and maintained in this kingdom as laid down by the Merchant Shipping Act 17 & 18 Vict., c. 104., is as follows:

The several Authorities mentioned in the Act are, 1st, the Queen in Council; 2nd, the Committee of the Privy Council for Trade; 3rd, the Trinity House; 4th, the two other General Lighthouse Authorities, namely, the Commissioners of Northern Lighthouses for Scotland and the Port of Dublin Corporation, or Ballast Board for Ireland; 5th, Local Authorities, of which there are about 170.

SYSTEM OF CONTROL.

1st. *The Queen in Council* may transfer to a General Lighthouse Authority the powers of a Local Authority within its jurisdiction making default in erecting, maintaining, or placing any local lighthouse, buoy, or beacon. (Sec. 395.)

The same power may consent to the following acts by the General Lighthouse Authorities:—Exemption from dues; alteration of mode of collection; substitution of dues (Sec. 398); and may fix dues for new lights, or alter their amount (Sec. 410).

So far as Your Commissioners are informed, the powers of Local Authorities have very rarely been transferred from the Local Authorities who exercise them. One case was the Light at Douglas, Isle of Man, lately transferred from the Local Authority to the Scotch Board. Provision has to be made for dues in such a case. Secs. 395 and 413 seem to give the necessary powers. Under Sec. 397 the Queen in Council may alter dues.

2nd. *The Board of Trade* may, on complaint of inefficiency, authorize persons to inspect all Lighthouses, Buoys, and Beacons under the General Lighthouse Authorities, and may at all times demand from them returns, explanations, &c. (Sec. 393).

From the evidence before Your Commissioners it appears that the first of these powers has been very little exercised, and that the latter *has* to a very great extent. See Correspondence, Abstracts, &c.

The Board of Trade may sanction interference with Local Authorities by General Authorities (Sec. 394), but Your Commissioners are not informed that they have ever been asked to do so. This section gives large powers to the General Authorities, but they have been exercised only to a very small extent, if at all.

On the contrary, it appears from a letter dated 9th February 1859 (see Vol. II. p. 631), that as regards the Harbour Lights marked in the Admiralty lists, the Board of Trade had “no information to enable them to state by whom they were then managed”; and it further appears, from the Return of the Scotch Board, that the Commissioners for Northern Lighthouses could only furnish a list of these Local Authorities, *so far as known*, and it does not appear from the Returns or from the personal observations of Your Commissioners or from the oral evidence, that local lights are inspected or interfered with to any extent by any of the General Authorities.

Your Commissioners have reason to believe that very little *control* of any kind has been exercised over the Local Authorities, and we generally found the lights to be less efficient than those managed by the General Lighthouse Authorities, and to be managed on no regular system of any kind.

The Board of Trade may direct the General Authorities to account for and pay over to the Paymaster-General the dues collected by them (Sec. 402), and this they have accordingly done. There was on February 6, 1860 a very large surplus, 361,645*l.* 1*s.* 2*d.*, invested in Exchequer bills and cash in the hands of the Paymaster-General. (See Return Light Dues, February 6, 1860. Parliamentary Paper.)

The Board of Trade may decide questions in dispute between the Trinity House and the other two General Lighthouse Authorities by granting or withholding their sanction, either wholly or partially, and either with or without modification in relation to the matters submitted to them (Sec. 406). The directions given by the Board of Trade in relation to the matters aforesaid shall forthwith be communicated by the Trinity House to the General Authority in question, and that Authority is bound to act in conformity therewith (Sec. 407). Under Sec. 408 the Board of Trade may sanction directions of the Trinity House to the other two Lighthouse Authorities, but we do not find that the Board of Trade are empowered by the Act to direct the Trinity House as to their *management*; and we are informed that the Board of Trade, whatever may be the nature and extent of the power which they actually exert, only *claim* “the control of the purse.”

Management
and control.

Queen in
Council.

Board of trade

(See Mr. Milner Gibson's Evidence, Q. 82.) But the power given to the Board of Trade by Sec. 405, which seems intended only to meet cases in which the Trinity House do not signify their approval of the works which the other General Authorities submit to them for their sanction, appears to have been taken to embrace other cases, and to include a power of control over the Trinity House; and such a power of control has been exercised in many instances in England, Ireland, and Scotland.

Under Secs. 408, 409, the Board of Trade have power to sanction directions originating with the Trinity House, and addressed to the other General Authorities, and they act as a Court of Appeal; but no case has been brought to the knowledge of your Commissioners in which this power has been exercised.

As illustrations of the manner in which the control of the Board of Trade is exercised the following may be cited. In the case of Godrevy the Trinity House, anticipating the non-concurrence of the Board of Trade on the score of economy, selected a site, but not the site they would have preferred, and it was finally adopted; but not until after several other sites had been suggested by the Board of Trade, and after a correspondence extending from the 13th July 1855 to 18th November 1857. (See Vol. I. p. 13, and Oral Evidence Qs. 69-74, 429-432, 926; and Vol. II. p. 63.)

Illustrations of
system of
control.

In the case of the lighthouse at North Unst, the Commissioners of Northern Lighthouses were over-ruled through the Trinity House, and a temporary lighthouse was built on a situation, of which the engineer of the Scotch Board disapproved. The men considered themselves to be in great danger when the bad weather came on, and they are now, as appears from the correspondence, cut off, (in the permanent lighthouse) from communication with the shore whenever the weather is foggy, because their Lordships would not sanction the laying of an electric telegraph which the Commissioners wished to construct; and the making of a path from the houses to the shore, to facilitate a walk of some miles over rough ground, was refused. The keeper on shore is now compelled to walk over hills in all weathers, and often in vain, for the signal hung out is frequently invisible from fog, when the observer arrives at the point from which the lighthouse can be seen in clear weather; and one keeper nearly lost his life in the performance of this duty. The great importance of this signal being made out *every day* is dwelt on by Mr. Cunningham in his evidence. (See Vol. I. Oral Evid., Qs. 478-481, 714-716, 760-767, 777-780, 941, 942; and Vol. II. pp. 165, 171; and MS. Correspondence.)

Again, the light at Holborn Head was made the subject of a voluminous correspondence lasting from 24th December 1856 to 9th February 1860. The cost of the site was 200*l*. The main questions in dispute—the breadth of a road, and whether the proprietor of the land should be entitled to use it—and the result is thus described in a letter from the proprietor: “The terms * * * are the same proposed by the Commissioners “and agreed to by me more than two years ago.” (See Vol. I. Oral Evid., Qs. 482, 724, 725, 735, 938, and p. 188; and Vol. II. p. 164; and MSS. Correspondence.)

The Ballast Board of Dublin, in 1854, were deprived of a steamer which they purchased in 1851, in consequence of the Board of Trade not considering it sufficiently used. The vessel was transferred to the Trinity House, and sold by order of the Board of Trade; the original cost was 18,500*l*., and the price realized about half that sum; and the Ballast Board forward stores to lighthouses in sailing vessels, make their inspections in steamers borrowed from the Trinity House, and shift buoys of large size by means of a small steamer called the “Midge,” which Your Commissioners saw, and considered to be wholly unfit for the seas of the Western Ocean. In consequence, as it is stated, stores are delayed, so as to endanger in some instances the extinction of lights in distant situations. The members of the Ballast Board are delayed and impeded on their inspections, and their movements being known long before-hand, their visits are expected and are less useful. The Buoy service is made one of considerable danger, and it is unquestionable that the money saved is quite insufficient to counterbalance the risk incurred, and other disadvantages. In this case the Board of Trade, as appears from the correspondence, not only deprived the Ballast Board of the steamboat contrary to the wishes of the Ballast Board, but entered into negotiations with Steamboat Companies for shifting lightvessels. (See Vol. I. Oral Evid., Qs. 144-153, 188-195, 201-214, 415-418, 856-864, and p. 19; and MS. Correspondence.)

The Commissioners for Northern Lighthouses were overruled in the selection of the Illuminating apparatus to be used at the Butt of Lewis, (see Vol. I. Oral Evid., Qs. 483, 941,) and again at the Lighthouse of Rhu Vaal, at the entrance of the Sound of Islay, as to the height,—as to the arc to be illuminated,—the colour exhibited,—and the purpose of the light. The decision was opposed to the opinion of the Surveying Officer on the district, and to that of the seamen and others acquainted with the locality; and it does not appear that it was wholly approved by the Trinity House. (See Vol. I. Oral Evid. Qs. 434-436, 845-850, 920-925, and p. 23; and MS. Correspondence.)

Illustrations
of system
of control.

The Lighthouse on the Iron Rock (Sound of Jura) remains unbuilt in consequence of a difference of opinion as to an estimate (9,360*l.*) for plans which had been approved by the Board of Trade, but which, as they maintained, must be executed, if at all, for a considerably less sum (6,000*l.*) than that which the engineer employed by the Commissioners of Northern Lighthouses considered necessary; a voluminous correspondence took place, which has ended in the complete suspension of all proceedings, to the detriment of the service. The Board of Trade, although fully admitting the remarkable accuracy of the estimates of the Messrs. Stevenson, as tested in numerous works by the ultimate expense incurred on them, refused to allow tenders to be invited for this Lighthouse, seeing apparently some connection which Your Commissioners have been at a loss to discover between the amount of an engineer's estimate, known only to the Authorities, and that of the tenders which follow it. (See Vol. I. Oral Evid., Qs. 467, 700 et seq., 926 et seq. and MS. Correspondence.)

When a gun was asked for as a fog signal on board the Kish lightvessel, the Board of Trade objected to the expense on the ground that it was for the benefit of vessels trading to the port of Dublin, and to the fact of a gun being fired, as it might possibly be mistaken for that at Holyhead by vessels that were not crossing the Irish Channel. Yet at length they consented to a large bell of peculiar construction, and afterwards allowed the gun instead, provided it was not purchased or maintained at the expense of the Mercantile Marine Fund, and if fired always twice in succession. (See Vol. I. Oral Evid., Qs. 224-232, 888-905.)

And so the power of the purse appears to be construed into the right to control the action of the Authorities in all matters, however minute, which involve the slightest expenditure.

The Board of Trade claims to exercise their power of control to this extent under Clauses 422 and 406 of the Merchant Shipping Act. It becomes a subject for consideration, how far the control so exercised is beneficial or necessary, and whether the saving in cost (if any) secured, is worth the time lost, and the danger run by ships during these lengthened discussions between the Authorities.

It appears to Your Majesty's Commissioners that the better and simpler course would be to make the Lighthouse Authority which ought to be responsible for the position, character, and everything connected with the work, responsible also for its cost.

As matters are at present, the Scotch Board and the Irish Board cannot be held responsible, for they have two masters over them; and as the Trinity House were practically overruled in the case of Godrevy, the real governing body has come to be the Board of Trade.

It is therefore important to consider whether the Board of Trade, when acting in strict accordance with the provisions of the Act, is the department of Government best constituted to form an opinion on subjects connected with coast illumination, and better able to judge of the necessity of establishing new works than the Authorities who propose them. For example,—Captain Bedford, the surveying officer on the west coast of Scotland, proposed the placing of certain buoys which he considered to be of importance for the interests of general navigation; the Commissioners for Northern Lighthouses approved of most of these suggestions, adopted some of them, and, on the 8th of March 1860, wrote for the statutory sanction of the Trinity House to the placing of these buoys. On the 21st of March, the Elder Brethren “did not feel that they would be “justified in recommending to the Board of Trade, that they (the buoys) should be placed “at the expense of the Mercantile Marine fund.” And, on the 9th of April, the Scotch Commissioners appealed to the Board of Trade, on the ground that the reasons given by the Elder Brethren were insufficient. They pointed out that some of the buoys were intended for the use of vessels navigating the Caledonian Canal, and others for those navigating the Sound of Jura, where it has been thought advisable to erect two large lighthouses for general purposes, and that other buoys were for other localities where beacons and lighthouses are in course of erection as part of the general scheme.

On the 20th of April, the Board of Trade sanctioned the placing of *one* of the proposed buoys, but it was stated that “as regards the other buoys, my Lords, without entering “into the question whether they would be useful for the local, rather than the general “trade, are not disposed to think them necessary, and must, therefore, decline to sanction “the expense.” (See MS. Correspondence.)

Assuming that this decision is strictly within the provisions of the Act, and setting aside the rights of the question, Your Commissioners deem it to be a matter for grave consideration whether the constitution of the Board of Trade is such as to make that department of the Government best able to judge of such questions. The surveying officer on the station, who has the best opportunity of judging of the facts, and the Commissioners, who are responsible for the work, are agreed. The Trinity House differ from both on a financial question; and the Board of Trade differ from all, and decide on a question of

Controlling
Department
considered.

expediency. They sanction the placing of one buoy, admitting the principle for which the Scotch Board contend, and so overrule the Trinity House; they refuse to sanction the rest, and so overrule the Scotch Board; and they give as their reason, that they do not consider those buoys necessary.

Controlling
Department
considered.

In this recent case then the principle of Government is clearly laid down, and brought into action. The refusal is on the ground of expediency; the question in dispute is not settled, but the umpire decides the matter from his own point of view, and so far as regards the Scotch and Irish Boards (if not the Trinity House itself) the principle of this case seems to be the ruling principle of the control as at present exercised by the Board of Trade over the Lighthouse Authorities.

If this is the principle authorized by the Merchant Shipping Act, the independent action of the Lighthouse Authorities has ceased to exist. (See Oral Evid., Qs. 915-917.) The governing authority has, in fact, become vested in the Board of Trade, though no provision is made by the Act to enable that department to judge more accurately of such matters than the Lighthouse Authorities who are controlled, and the Admiralty surveying officers, whose local knowledge has been disregarded. If the governing power is really vested in the Board of Trade, and if that department is so constituted as to be competent to conduct the service, the other Authorities are superfluous. On the other hand, if the General Authorities are necessary, and conduct their business satisfactorily, and are to be continued, their powers should not be thus limited or thus controlled.

As matters now stand, the whole management of the lighthouse service appears to be impeded by the opposing action of three separate governing bodies; and it does not clearly appear what advantage is gained to counterbalance the delay which results from this complicated system.

*Present system
objectionable.*

3rd. *Trinity House.* The next in order of the Authorities having charge of Lights, &c., is the Trinity House.

Controlling
powers of
Trinity House.

By Section 392 of the Merchant Shipping Act, that body may enter and *inspect* all Lighthouses under the management and control of the two General Authorities next in order; namely, the Commissioners of Northern Lighthouses, and the Ballast Board, Dublin.

By Section 405, it may *control* these two bodies, by refusing its sanction to new works, or to proposed alterations in existing works, but this power is subject to an appeal to the Board of Trade.

By Section 408, it may direct the other two to execute new works, or to modify or remove works in existence, &c.; but this power requires the sanction of the Board of Trade, and seems never to have been exercised.

As to the power of *inspection* over the other two bodies under Section 392. The Elder Brethren, in reply to Question 8, Circular I., Vol. II. pp. 13-19, have furnished a return showing the special services and inspections in which they were engaged in 1857 and 1858, from which it appears—

That from May 6th to 26th, 1857, "a committee (accompanied by Captain Sullivan, of the Board of Trade,) visited the west of Ireland" and "round Scotland," and that they were accompanied by officers of the Scotch and Irish Boards. The names of the places visited are given in detail, and include places on which Lighthouses have been erected, or on which it has been proposed to erect such works; places which have been the subject of much correspondence, in which the views of the Commissioners of Northern Lighthouses differed from those of the Trinity House, and the Board of Trade; for example, the Iron Rock in the Sound of Jura; Macarthur's Head, the Black Rocks, and Rhu Vaal, in the Sound of Islay. The lights visited were few, and the time short, and it was partly occupied in inspecting localities in England, in coaling, &c.

On the 17th of May 1858, a Committee of the Elder Brethren visited St. Abb's Head, accompanied by Captain Sullivan, three of the Northern Commissioners, and Mr. Stevenson.

This power of *inspecting* works not in England was, therefore, not exercised to a great extent in these two years by the Trinity House, either in Scotland or Ireland.

As to the power of *control* under Sections 405 and 408.

The cases in which the Scotch and Irish General Authorities have been *controlled* by the Trinity House will be found in the Scotch and Irish replies to Question 17, General Lighthouse Return; Question 19, General Floating Light Return and General Remarks, Circular II.; and Question 18, Buoys and Beacons, Circular V.; and in the evidence of Messrs. Cuninghame and Stevenson, Sir James Dombrain, and the Earl of Meath.

As respects Scotland the correspondence is voluminous. Abstracts are given of some portions of it in the Appendix; some of the cases are alluded to above; and the replies

Controlling
powers of Tri-
nity House.

of the Commissioners of Northern Lighthouses give further abstracts, and these will be found in Vol. II.

The action of the Trinity House throughout, as appears from that correspondence, has been subordinate to the action of the Board of Trade, and views apparently originating with the Board of Trade have been carried out, in cases where a difference of opinion had arisen between the Lighthouse Authorities on other points.

It seems, therefore, from these Returns, that the power of *inspection* conferred on the Trinity House has been sparingly exercised, and that the power of *control* and *direction* has generally served to transfer the decision from the Commissioners of Northern Lighthouses and the Ballast Board through the Trinity House to the Board of Trade.

SYSTEM OF MANAGEMENT.

System of
management.

The *management* of the Lighthouses, Floating Lights, Buoys, and Beacons on the coasts of the United Kingdom has been entrusted to what are termed the three *General Authorities*. They are the following :—

General
Authorities.

1st. *The Trinity House*, by the Mercantile Shipping Act, under Section 389, has the *superintendence and management* of all Lighthouses, Floating Lights, Buoys, and Beacons in England, Wales, the Channel Islands, Gibraltar, and Heligoland, except those which are under Local Authorities.

2nd. *The Commissioners of Northern Lighthouses*, subject in some matters to the *control* of the Trinity House and the *ultimate control* of the Board of Trade, have in Scotland, and in the Isle of Man, the *management* of Lights, Buoys, and Beacons, except those which are under Local Authorities.

3rd. *The Ballast Board of Dublin* have similar authority, subject to similar control and exceptions, in Ireland,

Under Section 396 of the above Act, these General Authorities may levy the same dues as formerly.

Under 398, they may, with consent of the Queen in Council, exempt from dues, alter the mode of collection, or substitute dues for other dues.

Under 401, they may, by their collectors, distrain for dues.

Under 402, they account, as is directed by the Board of Trade, and pay over the money to the Paymaster-General.

Under 404, they may build, remove, or alter Lighthouses, and place, erect, remove, or alter Buoys and Beacons, but the Scotch and Irish Boards must have the sanction of the Trinity House, and, in case of dispute, of the Board of Trade.

Under 415, they may prevent false Lights, under a penalty of 100*l*.

Under 394, with sanction of the Board of Trade they may compel Local Authorities within their several jurisdictions to lay down new Buoys, remove or discontinue Lighthouses and Beacons, and vary the character of Lighthouses and Lights.

And they may prevent the construction of new Lights by these Authorities.

Under 395 they may apply to the Queen in Council for the punishment of a defaulting Local Authority.

The powers then of these three General Authorities are twofold :—1st, the power under which they manage their own service ; 2nd, their control over Local Authorities.

Before considering the action of these General Authorities, it may be useful to give a short account of the origin and history of each.

GENERAL AUTHORITIES.

Trinity House.

1st. *The Trinity House*. As appears from the Report of the Select Committee on the Foreign Trade of the Country, 1822, the germ of the Corporation existed as early as the reign of Henry the Seventh, as an Association for Piloting Ships.

In the reign of King Henry the Eighth the Society was incorporated by Royal Charter (May 20th, 1514), and this Charter was confirmed and altered by Edward the Sixth, Queen Mary, Elizabeth, and James the First.

The Charter of James the First settled this constitution of the Corporation, and such it continues.

The Charter was dissolved in 1647, but was renewed by Charles the Second on the Restoration, and the disposal of the funds was settled partly for charitable purposes.

The Charter was surrendered to Charles the Second, and renewed by his successor in 1685 ; and the charitable uses of the funds of the Corporation were again settled. These funds were derived from various charges, such as Pilotage, Lastage, Loadmanage, Ballastage, &c.

The Light dues, the principal source of the revenues of the Corporation in 1822, and the source from which Lights are now supported, were chiefly collected under Patents granted by the Crown, upon the petition of persons offering to pay certain sums

for the erection of Lights; which dues the Crown authorized the Corporation to receive as a compensation for the erection and maintenance of the Lights required.

General
Authorities,
Trinity House.

The Corporation had also the power of erecting and maintaining Beacons and Marks of the Sea.

The first Light under the management of the Trinity House was erected in 1680, subsequent to the erection of several Lighthouses by private individuals; and these private persons, and their successors, and others, subsequently erected lights, obtained patents, and under them levied dues on passing ships; which, as trade increased, grew to be large incomes.

The following was the state of affairs when the Parliamentary Committee was appointed in 1822:—The Trinity House and private individuals were maintaining Lights and levying dues on passing ships, British and Foreign; the former applying their funds amongst other purposes to support charitable institutions, and the latter applying the surplus of the dues levied to their own uses as their own private property.

Parliamentary
Committees,
1822.

With this disposal of the funds, the Committee of 1822 found no fault, but they recommended the substitution of a tonnage rate for passing tolls, and the purchase of the interests of individuals in private and leased Lights, and that all these should be brought under one control.

In 1834, another Parliamentary Committee was appointed, which reported on the then state of affairs. 1834.

They dwelt strongly on the importance of the service, the impropriety of levying dues on shipping for the benefit of individuals, and on the different constitution of the Boards of Management in the United Kingdom; and they recommended—

That all public general Lights should be placed under one Board, resident in London, and conducted under one system of management.

That the Trinity House should have the management of all general public Lights in the kingdom; and that their rules should be altered and extended so as to admit Officers of the Royal Navy and other scientific persons.

The Committee considered that the admission of the Hydrographer of the Admiralty, and of other scientific persons, would give a strong impulse towards the execution of the duties assigned to the Elder Brethren; and they mentioned, though they did not recommend, the Board suggested by Captain Drummond,—namely, a Board to consist of four persons.

1, A Seaman (the Hydrographer to the Admiralty); 2, a scientific chemist; 3, a member of the Royal Society (an optician); and 4, the President or Vice-President of the Board of Trade, together with secretary and proper officers.

They recommended that the Central Board, when appointed, should examine every local Light on the coast. They considered the relative advantages of the Dioptric and Catoptric systems, and of the oxyhydrogen light, which was suggested as applicable to Lighthouses. They held that every necessary expense should be incurred for the maintenance of the best Lighthouses and Floating Light establishments which the state of science could afford; and that the Light dues should in every case be reduced to the smallest sums requisite to maintain existing, and to construct new establishments.

The reports of these two Committees are valuable, and contain much information; but it seems superfluous now to dwell on such of the evils as have been remedied; to refer further to private Lighthouses, which no longer exist, and to the levy of light dues for, amongst other purposes, the support of "poor mariners," a charity which is gradually being abolished. But as the portion of the Merchant Shipping Act, which relates to Lighthouses, appears to be the result of the 3rd Parliamentary Committee appointed in 1845 to consider the Lighthouse question, it is necessary to notice that report also.

It refers to that state of the law which existed in 1836, but which was subsequently altered in 1854 by the Merchant Shipping Act. 1845.

To the financial affairs of the Trinity House, and to their vested rights, which are also provided for in the same Act.

It states that the Lights in the United Kingdom were then in an efficient state.

That complaints were made of the amount of dues, not of the efficiency of the lights.

It recommends that there should be one central authority, namely, the Trinity House, of which body one third should be nominated by the Crown.

That Lighthouses should be maintained at public expense.

That the Trinity House should be repaid the sums spent by them in the purchase of private Lights, and failing the adoption of that recommendation the Committee point to the substitution of a Tonnage rate for passing tolls.

Trinity House.

The Trinity House is therefore a very ancient Corporation which has grown up and has to a certain extent altered with the times, but which is in the main the same corporate body which existed in the time of James the First, if not in the reign of Henry the Seventh.

Its present constitution is explained in detail in the replies to Circular I. It consists of the Master, Deputy-Master, Elder and Younger Brethren. The Elder Brethren are divided into honorary members and acting members. The master and the honorary members receive no remuneration. The acting members are retired Masters of the Merchant Service, except three, who are naval officers. They are recruited from the Younger Brethren, the majority of whom are masters and mates in the Merchant Sea Service, a few are naval officers, and the Corporation is a self-electing body.

His Royal Highness the Prince Consort is the present Master.

Northern Commissioners.

2nd. *The Commissioners for Northern Lighthouses* were incorporated by the 38th Geo. 3. c. 58., and their present constitution is given in their replies to Circular I.

They consist of two law officers of the Crown, the sheriffs of certain maritime counties, the provosts of certain Royal burghs, and the provost of Greenock, and were specially established in 1786, by Act of Parliament, for the management exclusively of lights, &c. in that country.

The Commissioners are unpaid, and hold their position ex-officio.

The Committees which recommended the constitution of a single Central Lighthouse Board necessarily implied the abolition of this separate jurisdiction, but no complaint was made as to its efficiency.

Ballast Board.

3rd. The present constitution of *The Ballast Board of Dublin* is given in detail in their replies to Circular I.

It consists of members of the Port of Dublin Corporation, who at present are mainly connected with the commerce of the Irish capital; but includes a retired naval officer, who previously commanded the Coast Guard in Ireland.

The Corporation acts under the 23rd Geo. 3. c. 19.; and the Lights were formerly under the superintendence of various other bodies, such as the Barrack Board and the Commissioners of Customs.

The Government of public general Lights in the United Kingdom is therefore entrusted to four bodies differently constituted.

1st. The Board of Trade, a department of the Government, whose president changes with the Government, whose members are not selected for their knowledge of the science of Lighthouse Illumination, and who have not necessarily any officers specially instructed in that subject.

2nd. The Trinity House, an ancient corporation, with a variety of duties, many of which are not connected with lights, &c., whose acting members are retired commanders in the Merchant Service, and naval officers; who have a paid engineer, but who have no paid officer attached to their body specially instructed in science, though they are allowed to consult with scientific men, and do consult Professor Faraday from time to time.

3rd. The Commissioners of Northern Lighthouses, a body consisting chiefly of gentlemen of the legal profession, who have no paid officer for the scientific department.

4th. The Ballast Board, a body whose acting members are merchants, bank directors and governors, magistrates, railway directors, &c., including a retired naval officer.

In short, the government of Lighthouses in the United Kingdom, their management and construction, are all confided to bodies of gentlemen of various employments, none of which necessarily afford them an opportunity of acquiring a knowledge of those branches of science which bear upon Lighthouse Illumination.

It is both interesting and instructive to compare the constitution of these Authorities with that of the Lighthouse Boards in other countries. (See Circular XL., Q. 1., in Vol. II.)

In France, the Lighthouse Service is under the Ministry of Public Works, and a special Commission called "Commission des Phares," which body consists of naval officers, marine engineers, hydrographers, members of scientific bodies, and other gentlemen, distinguished for their scientific attainments, in various professions, all of which have to do with branches of science connected with coast illumination. The general conduct of the service is under an officer called Directeur General des Phares, who is an engineer, and has other engineers under him; and in every district on the coast there are resident engineers employed about government works, and, amongst others, in the superintendence and construction and management of Lighthouses. The Commission have special workshops in Paris for testing and setting up illuminating apparatus, and they give directions to the manufacturers for every part of the Lighthouse apparatus, including the calculation of angles for prisms and curves for lenses, and

Foreign countries.

France.

Existing Light-house government.

similar important matters, for which no provision is made in the English system of government. France.

In the United States of America the lights are under one Central Board, constituted in 1852, and composed of a member of the Government, engineer officers, and officers of the army and navy, and civilians of high scientific attainments. America.

In Sweden the Lights are under the Admiralty, and managed by a director and officers who have military rank, and engineers; and the coasts are divided into districts and sub-districts allotted to these officers. Sweden.

In Norway, the service is under the Royal Marine Department, with a director and assistants. Norway.

In Turkey, it is under the Admiralty; but the department was at a loss to furnish information. Turkey.

In Hanover, the service is under the Director General of Waterworks. The Buoys are placed by pilots; and the Lights and Buoys are inspected by Inspectors of Waterworks. Hanover.

In Hamburg, they are under the Committee for Harbours and Navigation, under the direction of the Commander and Inspector of Pilots. Hamburg.

In Spain, the system of administration is the same as in France. The Lights, &c., are under the Department of Public Works, and under a permanent Commission composed of engineers of superior rank of the Corps of Roads, &c., and naval officers; and the captains of ports are instructed to suggest improvements and report on the Lights. Spain.

In Denmark, the service is under the Ministry of Marine, entrusted to one Light engineer and two Buoy inspectors, furnished with instructions relative to their respective official duties. Denmark.

In Russia the superintendence is dependent from the Hydrographical Department. Russia.

In Holland the management of Lights, Buoys, and Beacons rests with the Minister for the Marine, under whom are an Inspector General and seven Inspectors. Holland.

In Belgium the construction of lighthouses is under the Minister of Public Works, but when built they are handed over to the general direction of the Navy, which is under the Minister for Foreign Affairs. They, with the floating lights and buoys, are under the superintendence of the Inspectors of Pilotage. Belgium.

In Austria the superintendence of all the Lighthouses, Buoys, and Beacons belongs to the Imperial Royal Admiralty. The Deputies of the Exchange at Trieste attend to Lighthouses,—their erection, management, collection of dues, &c. The inferiors of the Admiralty attend to the superintendence of Buoys and Beacons. Austria.

The principle then in all foreign countries seems to be, that Lighthouse illumination, being highly important, and requiring special knowledge of certain subjects, should be entrusted to persons acquainted with those subjects, and that the government should be centralized. Principle of government abroad.

Whilst the practice in Great Britain seems to have been to entrust Lighthouse illumination to persons whose pursuits did not indicate any previous knowledge of the subject, and the fact that for 404 Lighthouses, and numerous Buoys and Beacons, there are at least 174 different Authorities under as many Acts of Parliament, shows that the principle of local and independent self-government has at all events not been lost sight of. (Vol. II. p. 280.) The Elder Brethren of the Trinity House, however, having been mariners, may be supposed to have had much experience of the practical wants of sailors, and to be peculiarly well versed in all that relates to lightships; while the Commissioners of Northern Lights, being gentlemen of the legal profession, whose position is a guarantee for their intelligence, may be supposed able to form a good opinion of the character and qualifications of candidates for the posts of secretary and engineer, and to exercise a wise discretion in selecting them, and to collect and form a correct judgment on evidence and matters of opinion relative to matters under their charge; and the Ballast Board, being constituted of gentlemen engaged in large commercial transactions, may be supposed to be well acquainted with general business, and fairly competent to form a correct opinion on such questions as the purchase of sites, and the tenders for the erection of new works, or the materials required for the maintenance of the service. (Vol. II. Circ. I.) Practice in Great Britain

The Lighthouse Boards of foreign countries generally include engineers, hydrographers, and professionally scientific men.

The General Authorities in the United Kingdom have employed engineers, and that these have been able men is testified by the works which they have erected. The Engineer of the Commissioners for Northern Lighthouses used to attend the Board meetings until January 1855, when, by the requirement of the Board of Trade, he ceased to do so, to the great regret of the Scotch Commissioners, who were thereby, as they stated, deprived of the presence of the only scientific member of their Board. (See Vol. I. p. 186, and Oral Evid. Qs., 675 et seq., 958, 959.)

*Hydrographic
aid by Admiralty.*

The Hydrographic Department of the Admiralty has frequently lent its services to the General Lighthouse Authorities, but they, of course, have had no claim upon that Department.

The Trinity House has consulted Professor Faraday as its scientific adviser since 1836, but it appears that he only gives his opinion or advice on such subjects as are submitted to him. The Northern Commissioners have had the great advantage of having associated with them the family of the Stevensons, who have given much attention to those departments of science which relate to Lighthouse illumination.

That the scientific element was very deficient in the system of Lighthouse management in 1834 was evident to the Parliamentary Committee which sat in that year.

That the scientific element continues to be deficient has been evident to your Commissioners from an early period of their inquiry. Many of the preceding observations have indicated this; but in addition they would draw attention to the following facts:—

1st. The present arrangements often betray an evident want of scientific thought. No greater proof of this can be given than what is contained in the paper on the Whitby Lights, printed in Vol. I. p. 63, together with the admirable reports of the Astronomer Royal, Professor Faraday, Mr. J. Chance, and Messrs. Stevenson, in Vol. I. pp. 77–102.

2d. The Trinity House, by having secured the services of Mr. Faraday, are fortunately prevented from ever finally committing themselves to the adoption of any impracticable scheme; but by their not having constantly present at their Board any scientific person, the carrying out of any invention may be seriously embarrassed, and some invaluable inventions may not be appreciated and thereby lost. (See the evidence of Mr. Cutler and Mr. Holmes, in regard to the Electric light, Vol. I. p. 167.)

3d. There are a great number of questions of a scientific character, having reference to lighting or buoying the coasts, which are as yet unsolved, and only require the attentive consideration of men of science accustomed to experimental investigation, to educe such results as will doubtless increase the efficiency of the systems now in use, and may lead to some extensive improvements. To some of these questions we have incidentally paid attention; and one of our number has drawn out a list of seventy-six separate investigations, which might be undertaken with a likelihood of profitable results. It is printed in Vol. I. p. 71.

4th. There is a large amount of scientific talent in the country which might easily be turned in the direction of the suggested inquiries. In corroboration of this opinion Your Commissioners would draw attention to the great mass of valuable information and suggestion which has been elicited from those scientific men—some of them of the greatest eminence—who have replied to Circular IX. These replies (Vol. II. pp. 589–630) are commended to the most careful consideration of whatever authority may in future have the charge of the lighting and buoyage of our coasts.

5th. As a test of the degree of scientific knowledge exhibited by the different Lighthouse Authorities, Your Commissioners asked for copies of the plans, specifications, &c., actually submitted to the manufacturers in ordering the last two sets of lenticular apparatus of large size or peculiar form. The resulting correspondence is given in Vol. I. p. 210, with an account of the different practice of the four principal Lighthouse Authorities, viz., the Board of Trade, the English, Scotch, and Irish Boards. From this it appears that in Ireland forms of tender are issued, “setting forth the arc intended to be illuminated, the number of panels and zones required, and that the apparatus shall be of the “best quality, and fitted together correctly;” in England, printed forms and lithographed drawings of small size are furnished to the contractors; while in Scotland, large working drawings and minute directions are given by the engineers employed by the governing authority, for the execution of apparatus specially designed by them for special localities.

In the case of the English and Irish Boards, the governing body does not originate the design. In Scotland, a design is furnished by the governing body, and the manufacturer has only to execute the order given.

The latter arrangement seems calculated to produce an advance in science; the former is simply an order for a well-known instrument, accompanied, in England, by drawings, which closely resemble those published by the manufacturers in their trade lists, and which are almost, if not quite, identical with the drawings in the trade lists of Mr. Wilkins, a gentleman who does not himself manufacture the glass of dioptric apparatus.

Here, then, seems to be a defect in the system of management. None of the Lighthouse Authorities have by their constitution any special knowledge of these branches of science which relate to the construction of the Lighthouse apparatus which they require. When they employ men who have made these particular branches of knowledge their study, the result is good. The Commissioners of Northern Lighthouses have in this respect shown themselves considerably in advance of the Elder

*Scientific
element
wanting.*

Brethren of the Trinity House, by employing an engineer who has studied Lighthouse illumination, and claims to have invented or introduced many improvements into optical apparatus, to prepare specifications for scientific work. The result of the opposite course adopted by the Trinity House is shown in the defects observed at Godrevy, the Start, the North and South Foreland, Whitby, &c.

Scientific element wanting.

EFFICIENCY AND ECONOMY OF GOVERNMENT.

The inquiry, "Whether the present system of *management* and *control* under which the Lighthouses, Floating Lights, Buoys, and Beacons on the coasts of the United Kingdom are constructed and maintained, according to the provisions of the "Merchant Shipping Act, 1854," is well adapted for securing the most efficient lighting and buoying of the coasts," has been to a certain extent practically answered in preceding sections of this Report. The different Authorities, whether general or local, differ widely in their plans of proceeding; and there is no power given in the Act over the internal arrangements of these separate bodies, much less is there any means of insuring uniformity of system. Thus each authority carries on its work in its own way, with a greater or smaller regard to uniformity of action, throughout its own jurisdiction, but with little, if any, regard to the system adopted in other parts of the United Kingdom.

System of management and control in regard to efficiency.

In France, the whole is arranged systematically. Lights are placed on a system,—that their lights should cross. They are inspected on system,—the size of the flame; the quantity of oil to be consumed in an hour, to produce a good light; the minutest detail is provided for and calculated to a nicety, and the whole system hangs together, and is under one man. It is a system eminently calculated to produce uniformity and a good result, and it has produced excellent results in a comparatively short time.

It is the Scotch Board that most nearly resembles the French Commission des Phares in its way of managing Lights, Buoys, and Beacons. There is this in common,—

They have, in the localities where the lights are situated, men of repute and of capacity; in France the Ingénieurs des Ponts et Chaussées always resident, and in Scotland the Sheriffs of the maritime counties occasionally present; and the members of the two Commissions are ex-officio intelligent men, and the actual working of the service is carried on by a small staff, and by men whose business it is, and has long been, to deal with Lighthouses, and all concerning them, and whose ideas, when carried out, are carried out to the full extent, and in all Lighthouses alike.

Generally, to inspect the minor arrangements of one Lighthouse in Scotland is equivalent to having seen them all, for the only variety seems to be in the Illuminating apparatus, which in very many instances is specially designed for the locality, and has to be separately examined before it can be fully understood; while in England the uniformity is rather to be found in the Illuminating apparatus than the minor details of the service, which vary in different Lighthouses. In Ireland not only is there a great want of uniformity as to the minor details, but they seem to be very much overlooked and neglected, while the apparatus is about equal to that of the Trinity House. (See Cruise of "Vivid," &c., Vol. I.

Uniformity desired.

There are some interesting points of comparison between the plans adopted by the different Boards which have not hitherto been adverted to, and which bear upon the *efficiency* of the service.

The Lighthouses under the management of the Trinity House, almost without exception, were found to be remarkable for their order and cleanliness. The Scotch Lighthouses are fully equal to the English in these particulars. The Irish were found to be inferior. Their keepers do not wear uniforms.* In their houses, in the light-rooms, and in other places where discipline, order, and cleanliness should prevail, the Irish Lights do not rank so high, though many of them were as well kept in all respects as any visited by Your Commissioners.

In all the English and Scotch Lighthouses the men are comfortably lodged. They are provided with books, which is a vast boon to men who pass so much of their time in solitude; and in Scotland this is felt to be so important that certain amusing periodicals are taken in by the Board for the use of the men. In Ireland the supply of books is small, and they are rarely changed. In France there are none. Periodical religious services are strictly enjoined in the English and Scotch Lighthouses and Floating Lights. In Ireland, owing chiefly to the differences in religious creed commonly existing in that country, this important point is not so easily arranged, and there are no services.

Details of management compared.

In England and Scotland medicine chests are provided in every Lighthouse and Lightship. In Ireland, as in France, there are none.

* This has very lately been allowed.

Details of
management
compared.

In English and Scotch rock stations, much attention seems to have been paid to securing a proper supply of good water. In some of the Irish rock stations it was found to be otherwise, and filters are sometimes greatly wanted.

The Scotch Lighthouses are supplied with clocks and sun dials in good working order. The English Lighthouses are also supplied with clocks, but only occasionally with sun dials. The Irish Lighthouses are occasionally supplied with dials, sometimes with clocks. In many instances the clocks were not going; in one, the keeper was dependent for his time on the punctuality of a railway train, which in clear weather was seen to pass on the neighbouring coast.

The English and Scotch Lighthouses have meteorological instruments, but the Irish are ill supplied with such instruments, and generally have none at all.

All the English Lighthouses have external lightning conductors. There are 11 of the Scotch which are not so provided. The Irish, with the exception of 6, are protected by the iron hand-rail from lantern to base, which forms a conductor.

System in
Scotland.

In Scotland, as in France, a drawing of the flame as it ought to be when at its best is framed and glazed, and hangs in every light-room; this is not to be found in England or Ireland.

In Scotland alone, a table of the time for lighting and extinguishing is hung up in the light-room. These times differ for every latitude, and are carefully calculated for each Lighthouse in Scotland, and the result is, as before stated, a considerable economy.

In Scotland whistles are placed in every lantern, which communicate with the rooms below by tubes, in order to summon assistance, if required, and to avoid the necessity of the keeper in charge leaving his post until relieved. There are no communicating whistles in England or Ireland or in France.

The Scotch Lights are inspected at least once a year by the Secretary or by the Superintendent of Lightkeepers, or by the foreman of Lighthouse repairs, officers that do not exist in the Trinity House or Ballast Board (See Oral Evid., Qs. 790-800); the English Lights are frequently inspected by a deputation of the Elder Brethren; but many of the Irish Lights on isolated rocks are left unvisited for two or three years on account of the difficulty of reaching them in bad weather in the "Argus," an inferior vessel belonging to the Trinity House, which is lent at considerable inconvenience for the occasion. The "Midge," the only vessel belonging to the Irish Board, is quite unsuited for the purpose of inspection.

In Scotland the keepers go through a regular course of instruction and training as extra keepers at Lighthouse stations where dioptric and catoptric apparatus exist, and have to pass an examination before they are entrusted with the care of a light. In England a preliminary course of instruction is gone through at the Trinity Board's establishment at Blackwall; and in Ireland there is no such system of instruction, certain questions only being put to the candidate on his presenting himself. (See Vol. II. pp. 35, 159, 224.) In Spain a Practical School for lightkeepers is referred to in the Spanish Report of 1858; and the school includes instructions in all that concerns the Lighthouse service, practically and theoretically in all the duties that lightkeepers may be called upon to perform. In France the keepers informed Your Commissioners that they had been carefully instructed in all that pertains to the machinery of the lamp, and that they had been required to take it to pieces, and set it up again, before they were entrusted with the care of a light. They showed their manner of levelling the burner and adjusting the lamp in the apparatus.

Comparative
merits of dif-
ferent Boards.

All these points influence the *efficiency* of the Lights, and there can be no doubt that of all the British Lighthouses visited by Your Commissioners the Scotch are in the best state of general efficiency, the English next, and the Irish third; and the Local Authorities, with certain exceptions, range far below the General Authorities.

As regards Floating Lights the Irish excel in some particulars, such as size and form of vessel; the Trinity House Lightvessels are, in these respects, inferior to them. From the nature of the English coasts they are more numerous, and they, as well as the Irish Lightvessels, are models of order, of cleanliness, and of well found ships. The Northern Commissioners have no Floating Light.

As regards the number of buoys there is no comparison. The Trinity House, as in the case of Floating Lights, have by far the greatest number to meet the requirements of the coast, viz., 356 in position, whilst the Northern Commissioners have 92, and the Ballast Board only 53. The buoys under the Trinity House are generally efficient and well maintained, and in many instances excellent, but hitherto they have been arranged on no general system. Those under the Ballast Board are also good in quality, and generally well managed, and they are arranged according to a system, and the colours used are black and red. Those under the Northern Commissioners are red and black,

and also arranged on a system, [which is the same as that in France; but they are inferior to the English and Irish in size and quality.

Were there a central Lighthouse Board for the whole kingdom, with resident representatives for Scotland and Ireland, it would naturally be its duty to carry out along the whole of the British coasts those plans of any of the existing Authorities, which had proved most efficient.

The inquiry whether "the present system of management and control under which the Lighthouses, Floating Lights, Buoys and Beacons of the United Kingdom are constructed and maintained according to the provision of the 'Merchant Shipping Act, 1854,' is well adapted for securing" its end, "with a due regard to economy," divides itself into two parts. There is the expense of management incurred by the different Authorities, and there are the expenses arising from the complicated system of control.

System of management and control with regard to economy.

1st. It is very difficult to compare the *expense of management* by the three General Lighthouse Authorities, partly on account of the different manner in which the respective Boards conduct their business, and partly on account of the different character of their respective works. In the subjoined table* the amount spent on *management* is simply compared with the amount spent on constructing or maintaining the whole works under their charge:—

Expense of management.

General Authority.	I. Total Expenditure of each Board, including the Expenses shown in the following Columns. Also the Expense of maintaining Lighthouses, Floating Lights, Buoys, Beacons, &c., and Superannuation Allowances to retired Officers.	II. Salaries of the Home Establishment, Office Expenses, Law Charges, Traveling Expenses, Salaries and Wages at the District Establishments, &c. &c. &c.	III. Ratio to the total Expenditure.	IV. Salaries and other Expenses connected with the three Central Offices.	V. Ratio to the total Expenditure.	VI. Expense of maintaining Steam and Sailing Vessels.	VII. Ratio to the total Expenditure.
	£ s. d.	£ s. d.	Per cent.	£ s. d.	Per cent.	£ s. d.	Per cent.
Trinity House -	172,285 0 6	32,073 13 0	18·6	18,482 5 1	10·7	18,825 10 5	10·9
Commissioners of } Northern Light- houses - }	59,746 15 3	4,476 13 1	7·4	3,664 13 3	6·0	6,596 18 0	11·0
Ballast Board -	46,658 2 3	3,945 4 10	8·4	3,164 7 3	6·7	754 17 9	1·6

If the items included in Col. II. be assumed as the cost of management, the Trinity House appears by Col. III. to be more than twice as costly relatively in this respect as the Ballast Board, which itself is somewhat more costly than the Northern Commissioners. If the Central Office alone is considered, as in Col. IV., the Scotch and Irish Boards maintain about the same relative position, while the English, though still much higher than either, does not present so great a contrast. But the expense of maintaining steamers and sailing vessels is not included in either of the preceding columns: it is placed alone in Col. VI.; and from that it appears that whereas the Scotch and English Authorities spent about 11 per cent. of their total expenditure on these vessels, the Irish spend only 1·6 per cent. It must, however, be borne in mind that the "Argus" steamer has been lent to the Irish by the English Board; and if the whole expense of this vessel were transferred to the Irish account (Col. VI.), it would reduce the English ratio to 9·6 per cent. and raise the Irish to 6·5 per cent., leaving the Scotch decidedly the most expensive authority in this respect, though in other items it is the most economical.

* In drawing up this table Your Majesty's Commissioners consulted a gentleman who is engaged by various departments of the Government in preparing financial statements. As in our instructions no reference is made to the source of the funds whence lights, buoys, and beacons are sustained, we have not alluded above, either to the total income from the lights under each General Authority, or to the income received by dues for each individual light. Information, however, on these subjects has been prepared for Your Commissioners with great labour and at considerable expense, and the results will be found in the Summary in Vol. I. p. 120, and Plate 4.

In the following table an attempt is made to compare the amount expended in management, and in the general maintenance of steam and sailing vessels (cols. ii. and vi. of preceding table), with the work done :—

General Authority.	Sites Illuminated.	Gallons of Oil burnt.	Spots Buoyed.	Cost of Maintenance and Repair.	Cost of Management and Vessels.
				£ s. d.	£ s. d.
Trinity House - - -	115	45,031	356	70,686 10 3	50,899 3 5
Commissioners of Northern Light-houses.	46	25,884	92	17,618 4 2	11,073 11 1
Ballast Board - - -	73	33,942	53	31,591 5 2	4,700 2 7

It will be seen that the sites illuminated by the Commissioners of Northern Light-houses, and the Ballast Board, amount together to 119, thus just exceeding those illuminated by the Trinity House, and that the amount of oil consumed (a measure of the light produced) is considerably more; but that, on the other hand, the spots buoyed in Scotland and Ireland together amount to only 145, which is 211 short of the number buoyed by the Trinity House. The cost of maintenance and repair of the whole is considerably more by the English than by the other two Boards together, but when it is remembered that the Trinity House maintains so many floating lights this will not appear surprising. This fact, however, and the additional 211 buoys seem not competent to explain the 35,125*l.* 9*s.* 9*d.*, which the Trinity House spends in management over and above what is spent by the other two Boards together.

A very large portion of the expense incurred by the Trinity House is for district tenders and superintendents. It amounted in 1858 to 19,012*l.* 4*s.* 8*d.* This sum might be mostly, if not entirely, saved by the employment of the staff of the Coast Guard, and the steam gunboats and sailing tenders of that force—a force which is likely to become a permanent institution of the country.

2nd. The present complicated system of government, and reference to superior Boards, involves, of course, a certain expenditure in clerical assistance, &c., but this would not be worth considering if the present system really conduces to true economy in the administration of the service. The Board of Trade has steadily kept economy rather than progress in view, but the saving they have thus effected has been represented as sometimes a false economy, and it has unquestionably led to much unsatisfactory correspondence, and in some instances to prejudicial delay. Neither has the control of the superior over the inferior Boards been always attended with a saving. Thus in the case of the Whalsey Skerries (Shetland), the Northern Commissioners were directed by the Trinity House and the Board of Trade to build the light on the outer rock instead of the site 700 yards within it, as they proposed. This entailed an additional expense of 10,000*l.* in construction, and involves an additional annual expenditure for maintenance. Yet the Northern Commissioners are still of opinion that the original site proposed by them was the preferable one for a large guiding light, such as that at the Whalsey Skerries was merely intended by them to be. (See Vol. I. Oral Evidence, Qs. 477, 713–716, 885, and MS. Correspondence.)

LOCAL AUTHORITIES.

It has already been shown that the Lights, Buoys, and Beacons under the jurisdiction of Local Authorities are, as a rule, and with some praiseworthy exceptions, inferior to those under the jurisdiction of the General Authorities. This will be evident from an inspection of the Returns furnished by the Local Authorities themselves, and printed in Vol. II., and of the personal observations of Your Commissioners on them, in Vols. I. and II. The following cases are some of those taken respectively from England, the Channel Islands, Wales, Scotland, and Ireland.

The harbour lights at Dover, Folkestone, and Newhaven, on the English side of the Channel, present a singular variety of faults, comprising among them nearly all those which can be committed in Lighthouse arrangements. Thus at each of these three much frequented ports there is a very inefficient illumination, while the travellers leaving them and crossing the Channel to Calais, Boulogne, or Dieppe, come at once to small but brilliant harbour lights, which are all dioptric, and in the construction and management of which there are displayed all the achievements of the science of illumination which have yet been imported into the French national system—a contrast by no means creditable to our country. (See Vol. I. pp. 49, 58, 59; Vol. II. p. 305; and the reference to the Harbour Light at La Rochelle in Vol. I. p. 38.)

Expense of system of control.

Supervision or control of Local Authorities.

Examples of management.

The Harbour Commissioners at Jersey derive a very large revenue from the shipping that enter the port of St. Heliers. They fully recognize the liability of this revenue to light and buoy the approaches to the harbour properly. This is very inefficiently done, especially as regards the buoyage. The owners of the shipping are very discontented. The Harbour Commissioners, after extensive correspondence, have failed to give some important information required; but the following fact has been elicited by one of our number, who was deputed to visit the island for the special purpose, namely, that a large sum, 15,000*l.*, the accumulation of harbour dues for some years past, had been appropriated to island purposes, which had no connection with the interests of the shipping. (See Vol. II. p. 321.)

Examples of
Management.

Numerous wrecks took place in the neighbourhood of Aberystwith on the night of 25th October 1859, whereby many lives were lost; and it appears that the losses were attributable to the harbour master not seeing that the pier and guide lights were put up, but going to bed instead. (See Vol. II. p. 285.)

The contrast between the works of the Northern Commissioners and those of Local Authorities in the same country, is well illustrated at Aberdeen and Peterhead. In the neighbourhood of each of these towns is one of the finest coast lights in existence; but at each the harbour lights are ill kept, though well provided with the essentials for efficient illumination. In neither case does the vicinity of a properly appointed lighthouse appear to have induced the Local Authorities to improve their own works. Nor has it incited the keepers to see how their business could be better carried out, although at Peterhead the keeper was anxious to do his duty, and asked the chairman of Your Commission to him give a lesson in cleaning reflectors! (See Vol. I. pp. 27, 66; and Vol. II. pp. 372, 394.)

At Boddam Harbour in Aberdeenshire, on the contrary, there are lights of small pretensions, merely extra-sized street lamps, glazed red, with reflectors behind the gas flames, but they are very efficient, because under the charge of an intelligent man, who is an "occasional keeper" at the adjoining Buchan Ness Lighthouse under the Commission of Northern Lights. (See Vol. I. p. 59.)

Numerous buoys marked the dangers of the Shannon some few years since; they have gradually been washed away and never replaced. The Local Government now responsible for properly marking the dangers are the Harbour Commissioners at Limerick, to whom this charge was transferred from a previous Board. It was in the time of the previous Board that the buoys were washed away. The revenues are considerable, about 7,000*l.* a year, but are entirely mortgaged to the Board of Works at Dublin as interest on a debt of over 200,000*l.*, a large portion of which, 80,000*l.*, as was stated, was expended on building a bridge across the river at Limerick, and an almost useless lock, which former conferred not the slightest benefit on the shipping, whose owners are charged with defraying the interest of the money expended on it. Sums are doled out to the Harbour Commissioners by the Board of Works for any repairs that are absolutely necessary; but these only go to increase the debt, of which about 25,000*l.* consists of accumulated unpaid interest. There appears, therefore, to be but little prospect of the urgent necessities of the shipping that frequent the port being properly supplied, unless the whole question is made the subject of a special inquiry. (See Vol. II. p. 410.)

At Sligo, the wreck of a yacht, the "Fancy," belonging to the Marquis of Drogheda, may serve as an instance of great neglect on the part of a Local Authority, either to replace and maintain in its position a buoy that had been washed away, and yet appeared on the charts, or to give such information of their intention not to replace it, as might serve as a sufficient warning to mariners that the buoy was out of position. The buoy in question had been washed away for more than a year, and had not been replaced, but it still appeared on the latest Admiralty charts; and we were unable to find any trace of any communication having been made by the Harbour Commissioners at Sligo to any Authority accustomed to disseminate information on such subjects. Hence the yacht was lost, and the owner is unable to obtain any redress. (See Vol. II. 416; and Vol. I. p. 136.)

Liverpool is the largest of the Local Authorities, and has 7 Lighthouses, 3 Floating Lights in position, 65 Buoys in position, and 10 Beacons. The numerous and critical channels leading to the Mersey are marked by these Lightvessels, and are admirably buoyed, the buoys being generally of a superior description, and effectively maintained. The same, however, can scarcely be said of the Lights on shore. (See Vol. II. pp. 326-340; and Vol. I. p. 61.)

Largest Local
Authority—
Liverpool.

From Aberdeen and many other ports it was impossible to obtain returns, though repeated application was made, but such as have been furnished show that almost every Authority has some peculiarity in its constitution or management, and that the management of Local Lights is as various as the constitution of the Authorities.

What has been said of the Superior Authorities is generally applicable to Local Authorities also. Those who manage Lights are not appointed to their offices because they have had any previous knowledge of the subject, and those whom they employ may or may not have the required knowledge. The keeper's salary varies from 200*l.* per annum with house accommodation, to 7*s.* 6*d.* per week without a house, or lower when their whole time is not required. The Lights are almost universally in worse condition and worse kept than those under the larger Authorities, and they are inferior to French Lights of the same class, which are under the same management as the great Sea Lights, and which are fully equal to them in proportion to their requirements.

As every Local Authority is independent of all the others, each acts on its own plan, and the result is great inequality and confusion. There is no uniformity in Tide Lights. A red light means danger at one place, and safety at another; the same number of flags or balls may mean two different things at neighbouring ports. The system of buoyage varies everywhere. Red is left on the one hand in sailing into Hull; on the other, in sailing into Liverpool, and the mariner who is familiar with the Liverpool system, meets one which is exactly the reverse in entering the port of Dublin. The Admiralty have adopted at Berehaven a system depending on the points of the compass; at Plymouth, one founded on the knowledge a man has of the distinction between his right and left hand in entering the port. In short, there is no uniformity in the system adopted for Local Lights, Buoys, or Beacons, and they are, generally speaking, inferior in quality. (See Vol. II. p. 280.)

Under Section 394 of the Merchant Shipping Act, the General Lighthouse Authorities, with sanction of the Board of Trade may compel Local Authorities within their several jurisdictions,—to lay down new Buoys; remove or discontinue Lighthouses or Beacons; and vary the character of Lighthouses or the mode of exhibiting Lights.

And they may prevent the construction or alteration of Lights by these Authorities.

Under 395, they may apply to the Queen in Council for the transference of the powers of a defaulting Local Authority.

Under Section 413, a Local Authority may surrender or sell any Lighthouse, Buoy, or Beacon, to the General Authority in the same country, to whom the dues become in future payable.

From the evidence of the General Lighthouse Authorities, it appears that these powers have been very sparingly employed, nor do they appear to consider that they have any jurisdiction in regard to the internal arrangements of Local Lights, or to the maintenance of Local Buoys and Beacons. It should be observed also, that the Act makes no provision for the alteration of the position, colour, or character of Buoys; hence there is no power to enforce a uniform system, however desirable such a system might be considered. (See the remarks of the Deputy Master of the Trinity House, Vol. I. p. 165.)

Your Commissioners think it very desirable that a uniform system of Tide lights and signals should be established, instances having been reported to us in which valuable ships have been lost from a mistake in their meaning, or the want of them. (Vol. II. p. 691.)

Your Commissioners wish to lay some stress upon the necessity that exists for a more extensive and careful distribution of Notices respecting changes in lights, &c., whether belonging to Local or General Authorities. We would recommend that, in addition to the present issue, as stated in the Admiralty letter of 1st February 1861, Vol. I., p. 215, Notices should be sent periodically to Your Majesty's Consuls at the principal ports abroad, and that the several changes of the current year, and the contemplated changes in the ensuing year, should be published quarterly in a cheap pamphlet, purchasable at the shipping offices at home, and at the consulates abroad; and that, in order to insure the masters of ships being provided with these Notices, they should form part of the clearing papers of at least those vessels that are bound on oversea voyages.

Although aware of the great advantages of local self-government, Your Majesty's Commissioners feel that such a state of things as exists in most of the harbours of this kingdom, demands the serious consideration of the Legislature, and that means should be adopted for permitting the exercise of a more effective control over such Local Authorities as may persist in mismanaging the interests entrusted to their charge. This control ought to extend at least to the maintenance, character, and colour of Buoys, to the use of efficient means of illumination, and to the exposure of improper application of dues. But no such control could be exercised without a knowledge on the part of the controlling Board of the actual state of the Local Lights, Buoys, and Beacons, and this could be gained only by *inspection*. Power is given to the Trinity House to enter any Lighthouse within the jurisdiction of the Northern Commissioners or Ballast Board, to view the condition thereof (Section 392), and as the Lights of Local Authorities

Want of uniformity.

Present power of supervision and control.

Uniform system of Tide lights and signals recommended.

Change in lights, &c. to be more fully notified.

Further supervision and control of Local Authorities recommended.

are said to be "within the jurisdiction" of the General Authorities, they may be supposed to be included; but here the permission to inspect ceases, no power being given to the Trinity House to inspect English Local Lights, or to the Scotch or Irish Boards to inspect the Local Lights in places under their jurisdiction; nor are either of the three empowered to examine Local Buoys or Beacons anywhere. Nor is it to be expected that were such power simply given to the General Authorities it would be exercised by them unless in special cases. What is wanted is such a systematic inspection of all Lighthouses, Floating Lights, Buoys, and Beacons, by some competent authority as shall serve the purpose of making known to the public, and to the inhabitants of the port themselves, the merits or deficiencies of the works in question. To gain this object, the inspector's annual report should be presented to Parliament and published; and further, to facilitate the general distribution of that portion which relates to the locality, the report might be printed in separate sections; and the Trinity Commissioners should have further powers in reserve to be called into play in cases of extreme neglect.*

COLONIES.

There appear to be at present various systems in force for the *construction, maintenance, and control* of certain Lighthouses in the Colonies under the Superintendence of Your Majesty's Government. See Vol. II. pp. 631-643.

System of construction, maintenance, and control.

There is a system provided in the Merchant Shipping Act Amendment Act (1855), see Clauses I. to VIII., which contemplates the erection of Lighthouses at or near Your Majesty's Colonies, with money to be raised by the Board of Trade under security of the dues to be levied in respect thereof, see Clause VIII., and also for placing the Lighthouses previously existing, or that may hereafter be erected, under the Act, which provides for the levying of Light Dues in the United Kingdom and Colonies on vessels that have passed or are about to pass such Lights; providing, however, that no such Light Dues shall be levied in any Colony without the sanction of the Local Legislature having been first obtained. The only Lighthouse erected under these clauses is that on Cape Race in Newfoundland. It appears that several applications have been made under this Act, see Vol. II., some of which have been declined, and some are still under consideration.

The Merchant Shipping Act Amendment Act appears to have arisen out of a correspondence between the Departments of the Board of Trade, the Admiralty, the Treasury, the Colonies, and Mr. Gordon, C. E., (see Parliamentary Paper No. 355 of 1855,) in which Mr. Gordon and the Admiralty press upon the attention of the Board of Trade the great importance of availing themselves of their position as defined in the Merchant Shipping Act, and urge them to proceed to aid in the erection and supervision of Lighthouses in or near the Colonies.

There are numerous Lighthouses in the Colonies to which our inquiry under the Commission does not extend, as they are not under the superintendence of Your Majesty's Government. The Board of Admiralty, in their letter of the 6th December 1854, evidently contemplated a much more extensive interference by the Home Government with the Colonial Lights, owing to the unguarded state of the seas bordering upon Your Majesty's possessions abroad, and to the bad condition or management of some of the existing lights; but the Merchant Shipping Act Amendment Act gives only very restricted permissive power to the Home Government, and leaves the faulty Lights as they were.

That other systems are in force may be shown by the following table:—

Colonial Lighthouses.			Date of First Exhibition.	By whom Constructed.	Sum Expended.	By whom Maintained and Controlled.	At what Annual Cost.
Gun Cay,	Bahamas	-	1836	Imperial Government.	£ 3,177	Imperial Government.	£ 1,080
Abaco	"	-	1836	"	3,967	"	"
Cay Sal Bank	"	-	1839	"	3,804	"	"
Great Isaacs	"	-	1859	"	15,814	"	"
Lobos Cay	"	-	1860	"	19,000	"	"
Cape Pembroke, Falkland Islands			1855	"	2,400	"	315

(continued).

* Since the above was written it has come to our knowledge that the Commissioners of Northern Lights recommended a similar system of control to be introduced in the first Merchant Shipping Act.

Colonial Lighthouses.	Date of First Exhibition.	By whom Constructed.	Sum Expended.	By whom Maintained and Controlled.	At what Annual Cost.
Cape Race, Newfoundland -	1856	Imperial Government.	£ 5,452	Board of Trade, Toll on Shipping.	£ 600
Breaksea Island, Australia -	1858	"	} 3,796 {	Imperial Government.	345
Point King " -	1858	"		Imperial Government.	—
Cerigo, Ionian Sea -	1857	"		Imperial Government and Ionian Colony -	—
Cape Point, Cape of Good Hope	1860	"	4,500	" -	—
Roman Rocks " -	Unfinished	"	5,514	"	—
Great Basses, Ceylon -	Not commenced.	"	42,236	—	—

Colonies.

It will be obvious from the foregoing table that the Board of Trade has not confined its action in the erection of Colonial Lighthouses to the powers provided by the Merchant Shipping Act Amendment Act, but has in the cases of the Great Isaacs, Lobos Cay, Cape Point, Roman Rocks, commenced since the passing of that Act, relied on the Imperial funds for their *construction*. Two of the above are *maintained* by Imperial, and two others by Colonial funds.

The Board of Trade evidently consider that it is still within their power, and that power will probably be exercised, to *maintain* certain Colonial Lighthouses, [although erected since the Amendment Act of the Merchant Shipping Act was passed,] entirely from the Consolidated Fund.

Control over the expenses of *constructing* certain Lighthouses in the Colonies is exercised by the Home Legislature, to whom are submitted all recommendations of expenditure on a Colonial Lighthouse. A certain undefined amount of *control* over the *maintenance* and *management* of some of the Colonial Lighthouses is recognized as consequent upon, and resulting from, aid more or less partial, having been given from Imperial funds, or from passing dues levied in consequence of any Act of Parliament to that effect. In practically enforcing this control we suppose the stringency would vary with the amount of the aid given, as compared with the total sum expended.

In respect to scientific points, or matters of detail in the management of these lights, we find that the practice of the Board of Trade has been to consult the Trinity House, or its officers, or to follow their procedure.

The machinery at the disposal of the Board of Trade for the construction, maintenance, and control of certain Lighthouses in Your Majesty's Colonial possessions, under the superintendence of Your Majesty's Government, appears in certain cases to have been insufficient. This insufficiency is especially apparent in the total failure to erect a Lighthouse at the Great Basses, Ceylon, where, at the end of five years, and after the expenditure of 42,000*l.*, a light imperatively called for is not yet commenced (see Vol. I. pp. 138–141, and Vol. II. pp. 632, 643, 646); and a most dangerous locality thus remains unguarded until the Board of Trade have received the report of the Government of Ceylon, on the expense of constructing and maintaining, as substitutes for the proposed Lighthouse, two Lightvessels, which have been recommended by the Admiralty Surveying Officers, specially employed for this purpose. The steps now adopted are those which should have been taken in the first instance, and which we recommend should be adopted for the future. We are therefore of opinion that the systems now in force for the *Construction*, *Maintenance*, and *Control* of certain Lighthouses in Your Majesty's possessions, under the superintendence of Your Majesty's Government, are not well adapted for ensuring the most efficient control of that service with a due regard to economy, and we beg to submit to Your Majesty that the following change is required:—

Change of System.

Your Commissioners would recommend that the powers of the Board of Trade, with regard to Colonial Lighthouses, be transferred to the new Central Authority about to be proposed, and that steps be taken by its members to acquire a complete knowledge of the requirements and legitimate wants of the trade passing near the British Colonial possessions, so that applications from any particular trade or colony shall not be either too easily granted, or too hastily refused.

To ensure this, we would suggest that the officers of Your Majesty's navy, either afloat or on shore, and especially surveying officers, and, in their absence, artillery and engineer officers, be made available for periodical inspection of existing Lighthouses in the Colonies,

Insufficiency
of present
system.

Change of
system recom-
mended.

and for reporting on petition for new Lights, or for transfer of old Lights, under the Merchant Shipping Act Amendment Act; and also generally on the want, if want there be, of Lighthouses for the safety of the passing trade.

If this practice is adopted systematically, and the Naval Commander-in-Chief be supplied with printed forms, to be returned periodically, the Lighthouse Board in England charged with the superintendence of certain Colonial Lights will always have in its possession such an amount of evidence collected on the spot by trustworthy and experienced persons, as will enable it to come to a sounder decision than can at present be possible in the absence of any such system.

CHANGE OF SYSTEM OF GOVERNMENT.

From an early period of our inquiry it has been evident to Your Majesty's Commissioners that changes might be advantageously made in the system of management and control under which the Lighthouses, Floating Lights, Buoys, and Beacons on the coasts of the United Kingdom, and certain Lighthouses in the Colonies, are constructed and maintained. The evils of a double, triple, or quadruple government, the anomalies arising from such a multiplicity of systems, and the want of certain necessary elements in all the managing Boards became more and more apparent as our inquiry advanced. Yet so complicated was the question, and so great are the interests involved, that it has demanded long and careful consideration on the part of your Commissioners before deciding on the nature of the change they would recommend. By a sort of exhaustive process a scheme of government has been arrived at, the reasons for which are more particularly set forth in the Chairman's letter attached to this Report, and whose words in describing the proposed change we have thought proper generally to adopt.

Change of
system of
management
and control.

It was beyond the province of this Commission to recommend any change in the fund for maintaining Lights, Buoys, and Beacons, but bearing in mind the possibility or probability of a change, they have so arranged the proposed scheme of government that it is equally well adapted,—1st, to the present system of levying tolls on the passing trade; 2ndly, to a system which has occasionally been suggested, viz., a tonnage rate, which promises some advantages, and, in addition to that of simplicity, a great economy, both of labour and expense, in collection; and, 3rdly, to that system which has been recommended to the Legislature by the four Special Committees that have been authorized to treat directly this important portion of the subject, viz., *that the expense of erecting and maintaining our Lighthouses should be defrayed out of the public revenue.*

Had the question submitted for the consideration of Your Majesty's Commissioners been how to form the most perfect system of Lighthouse Management for the first time, we should probably have suggested a simpler and more responsible form of government; but, regarding the subject in all its bearings, as we were bound to do,—considering the existing, almost national institutions, the extent of practical knowledge possessed by them, as well as the large machinery employed,—we have deemed it expedient to build on existing foundations rather than to reconstruct out of entirely new materials; and we, therefore, recommend that the government and management of the Lights, Buoys, and Beacons of the United Kingdom, and of certain Lighthouses in the Colonies, be vested in a new central authority to be denominated the Trinity Commissioners for Lights, and that the expenditure of such Commissioners be brought directly under the control of the House of Commons by an annual submission of their estimates, through the Board of Trade or the Board of Admiralty, as may be deemed best, and that when once the estimates have been approved of by Parliament the expenditure of the funds voted be entrusted to the sole discretion of the Trinity Commissioners, under the recognized system of imprest and audit.

To constitute this *Central Authority*, to be denominated the "Trinity Commissioners for Lights," it is proposed that four members be elected by the Elder Brethren in such a manner as will ensure the retirement and election, after the four first years, of one member annually, and that to these four be added one member for Scotland, to reside in Edinburgh, and another for Ireland, to reside in Dublin, elected every four years, the whole to be eligible for re-election; and, in addition to the above six members, who should be engaged in no other business, that one other member be selected by the Government with special reference to his scientific acquirements in those branches of knowledge which relate to Coast illumination, as enumerated by us in Circulars IX. and X., the whole subject to the approval of Government, and to have salaries commensurate with the importance of their duties and with the necessary engagement of their time. To these it is proposed to add the Astronomer Royal, the Hydrographer of the Admiralty, the Comptroller-General of Coast Guard, and one of the Professional Members of the

Central Authority recommended.

Board of Trade, which last four persons would be ex-officio "Trinity Commissioners for Lights," and should be liberally paid for their attendance at the weekly Boards, or oftener if summoned.

The appointment of a governing body such as is sketched out above implies the transference to it of the Lighthouse duties of the Board of Trade, Trinity House, Commissioners of Northern Lighthouses, and Ballast Board; and we recommend that the election of the Scotch and Irish resident members should rest with the public bodies whose members have so long and so zealously, and without gratuity, performed the Lighthouse duties in the two countries; and for the purpose of selection from time to time, it would be highly desirable that the Commissioners of Northern Lighthouses should continue to exist as a body constituted as at present.

The members, who would thus be resident in Scotland and Ireland, and whose duties in those countries would be generally executive, should receive the same salary as the four executive members of the Central Board, selected from the Elder Brethren; and as the subject of new works and changes would probably only be discussed at collective meetings in London, and at a time when the estimates were being prepared for Parliament, it would be proper that they should attend in London at that period, and on other occasions when summoned by the Central Board.

In addition to the increased responsibilities to be vested in the new governing authority, we recommend that the whole of the Local Lights and Buoyage in this kingdom be subjected to an annual inspection under the direction of the Trinity Commissioners for Lights, and an Annual Report of the same be presented to Parliament with the Lighthouse Estimates; that the powers already vested in the General Lighthouse Authority with regard to Local Lights, &c., by various Acts of Parliament, be put into more active operation; and that further powers be given, as already stated; and in the event of the expenses for Lights, &c., being defrayed out of the public revenue, that the Admiralty Lights, Beacons, and Buoys, exclusive of Mooring and Warping Buoys, be given over to the same body.

Special Staff recommended.

Staff.—Qualifications of a special order, such as are only to be found in a person trained to the business of what the Astronomer Royal, in his letter of the 10th November last, aptly terms an "Optical Engineer," are absolutely necessary for the staff of the Central Board. (See Vol. I. p. 87.) Such an officer should, therefore, be appointed, together with three Inspectors of Lights, one for each country, who should themselves be well acquainted with optical engineering. The clerical staff now employed in the management of Lighthouse business would be more than sufficient under the altered circumstances.

Though we recommend the assimilation and amalgamation of the entire Lighthouse systems of England, Scotland, and Ireland, yet, on account of the great extent of coast line in the three countries, we consider it desirable to retain an office in Edinburgh and another in Dublin, which shall be the ordinary head-quarters of the resident member of the Central Authority, with the secretary and inspector of Lights, attached to Scotland or Ireland respectively. In Ireland a marine inspector for Floating Lights and Buoys will be necessary, as at present; and another will be required for England, unless the Trinity Commissioners should continue to discharge that duty, as it is at present performed by the Elder Brethren.

Royal Society to visit.

Visitation of the Royal Society.—In order to satisfy the public that our Lighthouses, and the whole system of Lighthouse illumination, are in all respects what the highest state of science can produce, and the interests of this great maritime country require, Your Commissioners would recommend that Your Majesty should be advised to issue Your warrant appointing the President and Council with other Fellows of the Royal Society annually to visit the central establishment of the Trinity Commissioners, as is now the case with the Royal Observatory; and that the Trinity Commissioners for Lights should on that occasion submit a Report of their proceedings in all matters relating to the development of and improvement in Lighthouse illumination to the Visiting Board of the Royal Society; such Report to be presented to Parliament with the annual estimates.

Coast Guard to aid in lighthouse service.

Coast Guard.—We recommend that the officers of the Coast Guard be employed in that frequent inspection of the Lights by night which we have reason to believe is absolutely necessary to the incessant maintenance of the best flames, and to the due vigilance of the keepers; also that the gunboats and the tenders attached to this branch of the service should be employed, when practicable, for purposes of inspection, supply of stores, and changing of crews, in lieu of the expensive system at present in operation. See Vol. I. p. 71., and 228.

Representation in Parliament.

Representation in Parliament.—Whether the funds to be provided for the Lighthouse service continue to be raised by dues, or by the simpler and more economic mode of a

tonnage rate, or ultimately from Imperial funds, the estimates regulating the amount of these funds will have to be submitted to Parliament; and as the proposed Central Board would not be represented in, and would not be directly responsible to Parliament, some department of Government will have to present the estimates to the House of Commons, and whatever that department might be, it would necessarily in some sense be responsible for those estimates; but this responsibility should extend no further than to the being able fully to explain the several items of those estimates to the House.

This representative body, Your Majesty's Commissioners propose, should be either the Board of Trade or the Admiralty.

Admiralty or
Board of Trade.

In the various Statutes establishing the authority and duties of the Trinity House, the Office of the Lord High Admiral or that of the Commissioners for executing that office is frequently referred to; and it is impossible to read the evidence taken by the Committees successively appointed by Parliament in 1822, 1834, and 1845, to inquire into Lighthouse management, or the correspondence in the last twenty years between the Admiralty, the Board of Trade, and the Colonial Office respecting Colonial Lights, without it being apparent that not only the Board of Trade, but the Trinity House also, have more or less leant upon the Admiralty in fulfilling their duties, and that there must always be an official and essential relation betwixt the Lighthouse service and the Admiralty; but although the dependence of the one upon the other of these departments has in no degree diminished, but rather the contrary, yet in the Merchant Shipping Act, 1854, this connection is ignored, and the Admiralty nowhere appears in our Lighthouse polity, as set forth in that Act.

Nevertheless, the Admiralty is that department of the Government which more than any other possesses the means for effectually assisting in carrying on the Lighthouse service. These means consist of its able Hydrographic staff, both at home and abroad, and the necessary affinity existing between that staff and the Lighthouse service, as shown in the Admiralty letter of 1st February 1861 (Vol. I. p. 215), its present complete chain-work of Coast Guard stations and flotilla, under intelligent naval officers at every point of the coast (see Coast Guard Map, Vol. I.); and its employment of the ablest engineers of this country, whose estimate for a work, when once submitted, would scarcely admit of the prejudicial disputes which now retard the prosecution of important works.

On the other hand, we have the Board of Trade, a department having the general superintendence of matters relating to merchant ships and seamen, and which, since the passing of the Merchant Shipping Act, 1854, has had the control over the three General Lighthouse Authorities, and in its six years' exercise of that control much valuable experience must have been gained; it is also the department at present representing the Lighthouse Authorities in Parliament, it has—so far as the limited machinery at its disposal admits—devoted great attention to Lighthouse business, and has most scrupulously kept in check all Lighthouse expenditure; whilst, under the system as now proposed, the Board of Trade would have one of its professional members an *ex officio* member of the new Central Body.

Leaving it then an open question, to be decided by the Government, whether the Board of Trade or the Admiralty is for the future to represent our Lighthouse Government in Parliament, and reverting to the unanimous opinions of the several Parliamentary Committees, embodied as those opinions are in the recommendation of the Committee of 1845, viz. "*That all expenses for the erection and maintenance of Lighthouses, Floating Lights, Buoys and Beacons on the coast of the United Kingdom be thenceforth defrayed out of the Public Revenue,*" the representative duties would be confined to the presentation of estimates of a simple nature prepared by the Trinity House Commissioners in a comprehensive form, and the acquiring of information necessary for the full explanation of these estimates to the House of Commons; neither of which would involve an amount of trouble deserving of any consideration in weighing the relative advantages possessed by the two departments, or in deciding which is most likely to afford the largest amount of material support to the Commissioners appointed to carry out the Lighthouse service of the country.

Presentation of
estimates.

CONCLUSION.

Your Majesty's Commissioners would not close this Report without expressing their obligations to those Foreign Governments who have so courteously replied to our somewhat lengthy questions, and have furnished us with such elaborate drawings and descriptions; and in particular we desire to thank M. Reynaud, the head of the Lighthouse Department in France, whose readiness and endeavours to meet the wishes of Your Commissioners have been marked with the greatest care and goodwill, and from whose good offices they have derived valuable assistance,—and not from his services only,

but also from those of others connected with his department. To Señor Lucio del Valle, of the *Comision de Faros* of Spain our thanks are due also for much interesting information.

To our Secretary we are also greatly indebted. His peculiar genius and aptness for the work in hand has been remarkable, as shown amongst other particulars in the Drawings and Diagrams prepared by him; and some of the most valuable of our experiments have originated in his suggestions: his ability has also been shown in the arrangement, abstracts, and summary of the evidence.

We have already spoken of what is owing to the Astronomer Royal, and to those Scientific Men who have generously, and at the cost of valuable time, furnished such replies to our questions as cannot fail to be of use in the furtherance of an important science; and in the proposals sent to us by Manufacturers and others for improvements in tide lights, in the build of Lightships, in Lamps, &c, there is ample evidence of the skill and ingenuity available in this country for further facilitating the navigation of these shores.

In conclusion, Your Commissioners would humbly express their hope that the attention which they have given to the subject of the inquiry which they were commanded to undertake, may not be entirely fruitless; and that the remarks and observations contained in the Report now humbly submitted to Your Majesty may result in an improvement in Light-house Illumination, in a more complete system of lighting and marking the shores of Your Majesty's dominions, and in the furtherance of the interests of Commerce and of Humanity,—interests which Your Commissioners are fully sensible must ever hold a high place in Your Majesty's regard.

All which we humbly submit to Your Majesty.

Witness our hands and seals this 5th day of March 1861.

(Signed)

W. A. B. HAMILTON. (L.S.)

ALFRED P. RYDER. (L.S.)

J. H. GLADSTONE. (L.S.)

DUNCAN DUNBAR. (L.S.)

S. R. GRAVES. (L.S.)

J. F. CAMPBELL,
Secretary.

Thank-ge
Gent
Specially
Chairman

P. S. The Financial
Director of the Inquiry treats the
Secretary. He has left it to the
end. Because he has not yet got
the papers from the Privy House
and because when he gets them
he does not know what to do with
them. Unless he says that dogs
in England cost about the same
as in France. —

The dog question is likewise one
on which the Sec does not at
present see how his to enter —

To him it appears a glaring
anomaly to treat the expenditure
of a light horse as a local affair
a week on the extreme west of

Scotland or Ireland is as dangerous
for an English or American shipboard
for Liverpool as one on the West of
England and it seems ridiculous
to say that the Scotch or Irish board
should pay up for their dogs because
they crowd up — that their income
and expenditure should bear any
relation to each other. But with that
the opinion of the Sec ends and he
throws himself on the Commissioner
of the ~~Sea~~ ^{Shipping} tolls and abolished
there will be an end of the question

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LETTER OF THE CHAIRMAN

OF THE

ROYAL COMMISSION, LIGHTS, BUOYS, AND BEACONS.

After our many discussions on Lighthouse Government, I think I have gathered what would most probably be the views of my colleagues on that subject: I propose, therefore, to put in writing what I believe those views generally to be; and if I succeed in my interpretation of them, the following paper may aid in the completion of that part of our Report which relates to Management and Control,—remembering always there is some further oral evidence to be taken, and that Capt. Sullivan's examination is deferred till the last.

W. A. B. HAMILTON.

10th January 1861.

1. It has been necessary, during our inquiry, to bear in mind that it is not with the whole of the duties of the Corporation of Trinity House that this Commission has had to do; but with those only which relate to Lights, Buoys, and Beacons.

Range of
inquiry of the
Commission.

2. The same consideration was necessary in investigating the Irish lighthouse system. It was not with the Ballast Board of Dublin, as a Corporation, that we were dealing, but only so far as respects its management of Lights, Buoys, and Beacons.

3. It is different, however, when we come to Scotland; there we have a Board, the only Lighthouse Board (in the ordinary meaning of the term) in the kingdom; and this Board is denominated the Commissioners of Northern Lighthouses.

4. The Corporation of Trinity House was founded in the reign of Henry VII., "for the government and increase of the navigation of England, and the relief of poor mariners, their widows, orphans, &c.;" and in time the Corporation came to be charged with other duties, as, for instance, in the reign of Elizabeth, when an Act was passed enabling the Trinity House to erect sea marks, beacons, and signs of the sea, and to place buoys; and it was not until the year 1607 that the Trinity House could be properly said to have had any light for the direction of navigation upon the open sea, when by virtue of their statute of the 8th of Elizabeth, the Elder Brethren laid claim to one which had been set up in 1606 by Mr. Thomas Bushell, a private gentleman, at his own charge, and whom they afterwards admitted to be their tenant both for this and for other lights, as well as for certain buoys and beacons. The first floating light (the Nore) was applied for and placed in 1732.

Purposes for
which Trinity
House was
founded in
1514.

First Light-
house in reign
of James I.

First Light-
ship in reign
of Geo. II.

5. The members of the Corporation of Trinity House are self elected; and although the acting members appear to be selected from amongst the most respectable of the commanders of our mercantile navy sailing out of the Port of London, they are not chosen for any special qualification they may possess for the scientific duties connected with lighthouse service.

Members of
Corporation of
Trinity House
whence
selected.

6. In Ireland, the members of the Ballast Board, a Corporation instituted by Act of Parliament in 1763 for preserving and improving the Port of Dublin, are not even nautical men, with the exception of one retired naval officer; nor does it contain amongst its members any, with the above exception, that have been selected with reference to lighthouse requirements.

Ballast Board:
when estab-
lished, and for
what purpose.

7. With respect to Scotland, a Board consisting of two Law Officers of the Crown, the Sheriffs of certain maritime counties, the Provosts of certain Royal burghs and the Provost of Greenock, was specially established in 1786, by Act of Parliament, for the management exclusively of Lights, &c. in that country. As is the case in the Irish Board, provision does not seem to have been made in that Act for the members of the Scotch Board being persons conversant with lighthouse science or management; but in the exercise of these duties, special care has been taken by the Commissioners of Northern Lighthouses to secure the services of persons who were possessed of the necessary qualifications.

Scotch Board:
when estab-
lished, and for
what purpose.

8. We have thus, properly speaking, to deal with two corporations, the Trinity House in England, and the Ballast Board in Ireland, (but only as regards that portion of their duties which relates to lights, &c.) whilst in Scotland our business is simply with a Lighthouse Board.

Lighthouse
Authorities.

9. To illustrate the above, we have only to turn to Question V., Circular No. I., "Constitution of General Authorities, England;" and to Answer, page 7, Vol. II., where we shall find, that of seven Committees into which the 20 acting Elder Brethren of the Trinity House are divided, for the general business of that Corporation, one only, "The Committee of Lighthouses," consisting of four or five members and the chairman,

Executive
Lighthouse
business at the
Trinity House
conducted by
two Com-
mittees.

is required exclusively for the executive business of Lights, Buoys, and Beacons; and that they meet but once a week as a Committee, for that business; at the same time it forms part of the duties of another Committee, viz., "The Examining Committee," annually to inspect the sands between Yarmouth and the South Foreland, and other localities where changes are likely to have taken place; and it is under the supervision of this last Committee that all notices to mariners are framed and issued; but the duties of both Committees are purely administrative, jurisdiction resting with the entire Board whose sanction has to be obtained before any recommendation of a Committee can be carried into effect. The routine duties of the Committee of Lighthouses are fully set forth at page 7, Vol. II. Each of the acting Elder Brethren receives a salary of 300*l.* a year.

10. Again, with respect to Ireland:—the Answer to Question 2, Circular No. 1, page 211, Vol. II., shows that out of nine Committees into which the Corporation of the Ballast Board, consisting of 23 members, are divided for conducting its business, two only are specially appropriated to the executive business of the Irish Lights. These two Committees are entitled the Lightship, and the Inspecting Committees; the former consists of five, and the latter of six members, all unpaid. Important questions relative to Lighthouses receive the consideration of the whole of the Ballast Board.

11. The Scotch Board, as before stated, has none other than Lighthouse business to attend to, and is composed of twenty-eight unpaid Commissioners, though, under an Act subsequent to that of 1786, provision is made, under certain circumstances, for an addition to those numbers.

Proposed Central Board.

12. This Commission can hardly have arrived at the present stage of its inquiry without having come to the conclusion that the several Parliamentary Committees that have been appointed from time to time since 1822 to inquire into the Management of Lighthouses in this country, were justified in the view they took (without exception) of the expediency of those Lighthouses being under the management of one Board, resident in London.

13. The question now arises, admitting the necessity of such a Board, whether there exist materials or a groundwork on which an efficient Central Board could be constituted? and this is a point upon which, after our long and careful investigations, we are in a position to form some conclusion.

14. I have said above that the members of the Corporation of Trinity House are not selected for their special qualification for Lighthouse business; but this Commission has been brought in contact with most of the gentlemen of that Corporation who compose its present Committees for Lighthouses, &c., and I am sure that my colleagues must be satisfied as to the general ability, the intelligence, and the anxious desire of those gentlemen to fulfil the duties devolving upon them. The system of their election from among the Elder Brethren of the Corporation is stated at page 8, Vol. II.; and, adopting such Committee as a nucleus or basis upon which to frame a Central Board, let us consider the sort of infusion necessary to complete it.

15. It is manifest from our inquiries, that the elements essentially wanting are the *scientific* and the *hydrographic*; and these considerations have to do with the composition of the new Central Board as well as its staff.

16. The numbers as well as the qualifications of the members necessary for composing a Central Board, will now have to be considered.

17. Of the five Elder Brethren who now constitute the present Committee for Lighthouses, we find that not more than four are in regular attendance; and that number might be adopted as constituting the Trinity House proportion of a Central Board, to be denominated the "Trinity Commissioners for Lights," such four members to be elected by the Elder Brethren, subject to the approval of the Government, and to have such addition to their present salaries as might be considered commensurate with the increased importance of their duties, and with the necessary engagement of the whole of their time,* and to these four should be added one member for Scotland, to reside in Edinburgh, and another for Ireland, to reside in Dublin; and in addition to the above six members one other member should be selected by the Government with special reference to his scientific acquirements in those branches of knowledge which relate to coast illumination, as enumerated by us in Circulars 9 and 10,

* The four Commissioners elected in the first instance by the Corporation of Trinity House, to hold their appointments for four years, at the end of which time one of these Commissioners will retire by ballot, and in each succeeding year another to retire in like manner, till the four originally elected shall have been worked off; after which, one Commissioner to retire by rotation every year. All members retiring, to be eligible for re-election: vacancies to be filled up by the Trinity House. All elections to be subject to the approval of Government.

Executive business of Irish Lighthouses, conducted by two Committees of the Ballast Board.

Nature of business, and number of members composing Scotch Board.

Views of Parliamentary Committees as to the expediency of one Central Lighthouse Board.

Question as to composition of a Central Board.

Trinity House Committee for Lighthouses the groundwork for a Central Board.

Necessity for introducing new elements.

Numbers and composition of the new Central Board.

with a suitable salary. To these should be added the Astronomer Royal, the Hydrographer of the Admiralty, the Comptroller-General of Coast Guard, and one of the Professional Members of the Board of Trade, which last four persons would be ex-officio "Trinity Commissioners for Lights," and should be liberally paid for their attendance at the weekly Boards, or oftener if summoned. It would be competent of course to the Government to increase the number of the Central Board.

18. With respect to the Scotch and Irish members of the proposed Central Board, this Commission cannot doubt that a fit person for such appointment is now to be found amongst the Commissioners for Northern Lighthouses, and in the Ballast Board of Dublin, respectively; and I am sure my colleagues will be of opinion that the selection of these members, either from their own body or elsewhere, should rest with the above gentlemen [subject always to the approval of the Government], who have so long and zealously, and hitherto without gratuity, performed the Lighthouse duties in Scotland and Ireland. The Scotch and Irish members of the Central Board should hold their appointments for four years, and be eligible for re-election; and the Commissioners of Northern Lighthouses, who are unpaid, might continue to exist as a body constituted as at present, for the purpose of selecting from time to time the person who is to be the Scotch member of the new Central Board.* The members, who would thus be resident in Scotland and Ireland, and whose duties in those countries would be generally executive, should receive the same salary as the four executive members of the Central Board, selected from the Elder Brethren; and as the subject of new works and changes would probably only be discussed at collective meetings in London, and at a time when the estimates were being prepared for Parliament, it would be proper that they should attend in London at that period, and on other occasions when summoned by the Central Board.

Mode of selection of new Scotch and Irish Commissioners.

Commissioners of Northern Lighthouses to remain incorporated for special purposes.

19. And in order to satisfy the public that our Lighthouses, and the whole system of Lighthouse illumination, are in all respects what the highest state of science can produce, and the interests of this great maritime country require, the Queen might be advised to issue Her warrant appointing the President and Council with other Fellows of the Royal Society annually to visit the central establishment at the Trinity House, as is now the case with the Royal Observatory; and that the Trinity Commissioners for Lights should on that occasion submit a Report of their proceedings in all matters relating to the development of and improvement in Lighthouse illumination to the Visiting Board of the Royal Society; such Report to be presented to Parliament with the annual estimates.

Royal Society annually to visit Central Establishment.

Staff of Central Board.

20. The next point for consideration is, the staff for the proposed Central Board. All our observations—all our experiments, go to show that qualifications of a special order, such as are only to be found in a person trained to the business of what the Astronomer Royal, in his letter of the 10th November last, aptly terms an "Optical Engineer," are absolutely necessary. The qualifications that such a person must bring with him are clearly set forth in that valuable paper; and it might be necessary for purposes hereafter to be mentioned, that such officer should have the assistance of three Assistant Optical Engineers (who will also be "Inspectors of Lights,")—one for England, one for Scotland, and one for Ireland; whilst, as regards the clerical staff, that now employed in the department of the Trinity House for the management of Lights, &c., would be amply sufficient.

Numbers and composition of the Scientific portion of the Central Staff.

21. It is true that at first sight the Trinity House would seem to be supplied with all that could be required of an Optical Engineer and Inspector of Lights; for the Elder Brethren have had at their command, and have, to a certain extent, availed themselves of the talents and genius of a Faraday, and to say that science were wanting where Professor Faraday is the scientific adviser, would seem to be a contradiction in terms; but it was necessary, as this Commission have seen, to turn those talents and that genius in the required direction, to secure to the science of Lighthouse illumination, that perfection which it has been the aim of this Commission to prepare the way to; and it was in consequence of the researches and experiments of this Commission, that the great talents of Professor Faraday were directed to those points which we now find essential for the best production of light,—its perfect adaptation to a costly illuminating apparatus,—and the most correct adjustment of that apparatus for Lighthouse purposes.

Better application of Professor Faraday's services;

22. All these are subjects that a Faraday's powers have promptly mastered since

Prof. Faraday should be pro-

* In the event of any new Act appointing Commissioners for Northern Lighthouses, for the purposes above stated, it might be necessary to introduce some such clause as the "XVIII. Cap. ci., 26 George III., 'relative to the erection of Lighthouses in the northern parts of Great Britain;' in which clause provision is made for 'the meetings of the Commissioners.'"

perly remunerated for these services, when more properly applied.

attention has been called to them by this Commission; but precisely in proportion to the great scope of his talents, is the difficulty of their being absolutely, and at all times, at the command of the Trinity Commissioners for Lights; for, assuming for the moment that Professor Faraday were the Optical Engineer to the new Board, that appointment must carry with it the employment of his whole time. The scientific world, however, could not afford that a Faraday's talents should be *entirely* devoted to Lighthouse duties, but whatever portion of his valuable time and peculiar talents he can afford to the Central Board, for that time and for the use of those talents he should be amply remunerated.

Transference of the duties of the Scotch and Irish Boards.

23. The appointment of a Central Governing Board as above sketched out, implies the transference to it of the Lighthouse duties of the Scotch and Irish Boards; but the absolute necessity for thus simplifying the present cumbersome scheme of Government has been apparent to us from the first, and does not necessarily imply the slightest reflection on the management of those Boards, which will for the future be represented by the two Commissioners to be elected by those Boards.

Merits of Scotch and Irish Boards.

24. I do not now enter at large upon the respective claims of each; but whilst the Scotch and Irish Boards are not without their merits, and may fairly be described as Lighthouse Establishments working under difficulties, the Scotch Board deserves to be especially praised for the admirable management of its Lights, though the costliness of some of its works, (a costliness probably of easy explanation,) in some measure accounts for what would otherwise seem to be an over jealous exercise of control on the part of the Board of Trade.

Staff for Scotland and Ireland.

25. The question of the staff sufficient for the Scotch and Irish service has now to be considered.

Lighthouse systems in England, Scotland, and Ireland to be assimilated.

26. We have seen the necessity for assimilating and amalgamating the entire Lighthouse systems of England, Scotland, and Ireland, yet the multifarious duties of the three establishments, together with the great extent of coast line in the three countries, will render necessary the continuance of a small scientific staff in Scotland and Ireland, in conjunction with the Commissioner, or member of the Central Board, resident respectively in those countries.

Staff for Scotland and Ireland.

27. It is probable, therefore, that a Secretary, together with an "Optical Engineer and Inspector of Lights," will be required in Scotland; and it might also be advisable to retain, if possible, for certain duties, the services of the Messrs. Stevenson, the engineers at present employed by the Scotch Board, who have devoted a large portion of their time and talents to the science of Lighthouse illumination, and with great success; whilst for Ireland, (where we have an overworked engineer,) a Secretary, together with an "Assistant Optical Engineer and Inspector of Lights," with the present "Marine Inspector" for Floating Lights and Buoys, will be necessary. In Scotland there are no floating lights.

Authority to be given to Central Board over local lights, buoys, &c., and report to be made to Parliament.

28. In addition to the increased responsibilities which we contemplate vesting in the Central Board, I believe we are prepared to recommend that the whole of the Local Lights and Buoyage in this kingdom shall be annually inspected under the direction of the Trinity Commissioners for Lights, and that an Annual Report on the subject should be presented to Parliament with the Lighthouse Estimates;—that the extensive powers already vested in the Trinity House with regard to local lights, &c. by various Acts of Parliament should be put into more active operation; and that further powers should be given to the General Lighthouse Authority to enforce on Local Authorities, not only the placing as at present of a Buoy, but the continued and effective maintenance of it in its proper position; and in the event of the expenses for Lights, &c. being defrayed out of the public revenue, that the Admiralty Lights, Beacons, and Buoys, exclusive of Mooring and Warping Buoys, be given over to the same body. Assuming such to be the views of the Commission, the necessity for attaching the three Assistant Optical Engineers and Inspectors of Lights to the central staff, to aid in the inspection, and in reporting on the general and local lights, in England, Scotland, and Ireland, will be apparent.*

29. So far we have been considering a Central Board of government and its Staff: the next question relates to—

Representation in Parliament.

Precedents for erecting and maintaining Lighthouses from Imperial funds.

30. The principle that the cost of erecting and maintaining Lighthouses may be defrayed out of the public revenue, appears to have been already sanctioned by Parliament; for, looking to the Merchant Shipping Act Amendment Act 1855, and to the Board of Trade's letter to this Commission, dated 25th January 1860, it

* The Astronomer Royal in recommending the appointment of an "OPTICAL ENGINEER," observes (in his letter of the 10th November 1860), that the examination of existing Lighthouses by such officer would probably occupy the two first years of his time.

seems that some of our Colonial Lighthouses,—for instance, those at the Bahamas and at the Falkland Islands, have been *erected* and are *maintained* entirely out of Imperial funds, and are entirely under the control of the Board of Trade; that other Lighthouses, such as those at King George's Sound, Western Australia, have been *erected* and are to be *maintained* by Imperial funds until such time as the colony is in a position to maintain them itself; and that others, such as the Lighthouse at Cerigo, have been *erected* with Imperial funds, and are *maintained* jointly by Her Majesty's Government and the Ionian Government;—that the cost of *erection* of the Roman Rocks Lighthouse at the Cape of Good Hope is to be borne by Imperial funds; and that sums have been from time to time voted by Parliament for the *erection* of Lighthouses at the Great Basses, at Vancouver's Island, and at Cape Point Lighthouse, Cape of Good Hope, and that Parliament will be asked for additional sums for the same purposes. This practice, sanctioned by the Legislature in so many instances, is, in a certain sense and to a certain extent, giving effect to the recommendation of the various Parliamentary Committees that have been appointed since 1834 (including the Committee on Merchant Shipping appointed in this year), viz., *that the expense of maintaining our Lighthouses, &c. should be defrayed out of the public revenue*. In speaking, therefore, of a change in the system of Lighthouse Government, although it may be beyond the province of this Commission to pass an opinion as to the mode of raising the fund for maintaining the Lights, &c., or to say out of what funds provision for the expenses of Lights, Buoys, and Beacons should be made, yet this is a question impossible to be lost sight of in considering the form of government best adapted for our Lighthouse system.

31. And herein lies our difficulty,—that we are directed “*to inquire whether the present system of management and control under which the Lighthouses, Floating Lights, Buoys, and Beacons on the coasts of the United Kingdom are constructed and maintained according to the provisions of the ‘Merchant Shipping Act, 1854,’ is well adapted for securing the most efficient lighting and buoying of the coasts of the United Kingdom, with a due regard to economy; or whether any, and if any, what change might be advantageously made in that system;*” and whilst (as is the case) our inquiry has led to the conclusion that some change is required in order to “*secure the most efficient lighting and buoying of our coasts,*” and we are prepared to recommend a change, we are met at the outset by that clause in our instructions, which would seem to point to the existing provisions of the “Merchant Shipping Act,” an Act which by transferring the Light Dues to the Mercantile Marine Fund, does at the same time give to the Board of Trade the entire control over those Authorities who are really chargeable with “*the lighting and buoying of our coasts.*”

32. If, therefore, the proposed change should at all appear to be a step beyond the bounds imposed upon us, yet it may be allowed to possess this advantage, that if not strictly adapted to the present “*provisions of the Merchant Shipping Act,*” it is at least adapted,—1st, *to the present system of levying tolls on the passing trade;* 2ndly, to a system which has occasionally been suggested, viz., a tonnage rate, which promises some advantages, and, in addition to that of simplicity, a great economy both of labour and expense in collection; and, 3rdly, to that system which has been submitted to the Legislature by the four Special Committees that have been authorized to treat directly this important portion of the subject, viz., *that the expense of erecting and maintaining our Lighthouses should be defrayed out of the public revenue.**

33. Whether the funds to be provided for the Lighthouse service continue to be raised by dues, or by the simpler and more economic mode of a tonnage rate, or ultimately from Imperial funds, the estimates regulating the amount of these funds will have to be submitted to Parliament; and as the proposed Central Board would not be represented in, and would not be directly responsible to Parliament, some department of Government will have to present the estimates to the House of Commons, and whatever that department might be, it would necessarily in some sense be responsible for those estimates; but this responsibility should extend no further than to the being able fully to explain the several items of those estimates to the House.

34. The 422nd section of the Merchant Shipping Act, 1854, provides that “each of the General Lighthouse Authorities shall from time to time submit to the Board of Trade

Proposed change adapted to present system of levying tolls, or to other modes of providing funds.

Necessity for Parliamentary representation.

* The saving of a considerable sum incidental to the collection of light dues must be borne in mind as connected with the question of their abolition. At the port of Liverpool five clerks, with an aggregate salary of 1,098*l.* 10*s.*, are required for the calculations and collection of light dues; and at the port of London the salaries of the clerks fulfilling those duties, including the collection of the Trinity House Pilot Dues, amounts to 800*l.* a year. The salaries of clerks employed at the Trinity House for examination, &c., of accounts for collection amount to about 700*l.* a year.

"estimates of all expenses to be incurred by them." Doubts are entertained by the above Authorities as to the strict legality of the Board of Trade's interpretation of that section, as exhibited in their minute interference with the mode in which those Authorities carry out their works after the estimates for them have been finally approved by the Board of Trade; but, setting aside these doubts for the moment, and without dwelling at any length on the very considerable increase of correspondence arising out of that Act, and without referring to the prejudicial delays that may be attributed to the present working of that particular section of it, it is difficult to discover the necessity for that cumbersome system which now exists under the two Acts, the Merchant Shipping Act Amendment Act, 1855, and Merchant Shipping Act, 1854, viz., a *single government* (the Board of Trade) for Lighthouses in the British Possessions abroad, a *double government* for the Lighthouses under the Trinity House, a *triangular government* for the Scotch Lighthouses and for Local Lights in England, and a *quadrilateral government* for the Irish Lighthouses* and for Local Lights in Scotland and Ireland;—a system which can scarcely be expected to find favour in the present day.

35. The machinery at the disposal of the Board of Trade in much that relates to "*the construction, maintenance, and control of certain Lighthouses in our Colonial Possessions*" would appear, from certain papers and from parts of the evidence that have come before us, to be in some cases insufficient. It cannot be denied that this insufficiency is in a great degree made up for by the talent and assiduous devotion to their duties of those officers of the Board of Trade on whom the Lighthouse business devolves; and in Capt. Sullivan as one of the professional members attached to that Board, and in Mr. Farrer, the Secretary of the Marine Department, as well as in Mr. Williams the Accountant, there is all that can be desired in official talent and zeal. In Capt. Sullivan the Board of Trade has the assistance of an eminent naval officer, who stands deservedly high in his profession and with the public, and who, in addition to his accomplishments as a sea officer, has this one eminent qualification, that he is a superior hydrographer; but the qualifications embodied in Capt. Sullivan, though most valuable as far as they go, do not comprise all that is necessary in a department which has the entire control over our Lighthouse Boards; for not only is it the case that the necessary qualifications can scarcely be found in any one individual, but we may assume that in carrying out an Act which has for its object the "amendment and consolidation of the Acts relating to Merchant Shipping," an Act containing 548 clauses, and having one of the eleven parts, into which it is divided, appropriated to Lighthouses, that Capt. Sullivan, who, in addition to the demands upon his time which the working of that Act may be supposed to entail, is also one of the Thames Conservators, has other and important duties to attend to besides those connected with Lighthouse control; nor would it appear that he has any qualified staff attached to him to whom could be deputed the due performance of every one of those duties connected with Lighthouse government which we now find to be necessary.

Board of Trade or Admiralty to represent Lighthouse Board in Parliament.

36. The question now arises, what public department of the Government could most advantageously be connected with the new Lighthouse Board, and be charged with representing that Board in Parliament.

37. In the various Statutes establishing the authority and duties of the Trinity House, the office of the Lord High Admiral or that of the Commissioners for executing that office is frequently referred to; and it is impossible to read the evidence taken by the Committees successively appointed by Parliament in 1822, 1834, and 1845, to inquire into Lighthouse management, or the correspondence in the last twenty years between the Admiralty, the Board of Trade, and the Colonial Office, respecting colonial lights, without it being apparent that not only the Board of Trade, but the Trinity House also have more or less leant upon the Admiralty in fulfilling their duties, and that there must always be an official and essential relation betwixt the Trinity House and the Admiralty; but although the dependence of the one upon the other of these departments has in no degree diminished, but rather the contrary, yet in the Merchant Shipping Act, 1854, this connection is ignored, and the Admiralty nowhere appears in our lighthouse polity, as set forth in that Act.

38. Nevertheless, the Admiralty is that department of the Government which more than any other possesses the means for effectually assisting in carrying on the Lighthouse

* See pages 212, 213, Vol. II., where the Act 26 Geo. 3. c. 19. is referred to, which provides that no appointment connected with lighthouses in Ireland can take place without the approval of the Lord Lieutenant, whilst the like sanction by the Board of Trade is required.

Present
complicated
system of
government.

Insufficiency
of machinery
at the com-
mand of Board
of Trade.

Dependence of
the Trinity
House on the
Admiralty.

Admiralty
might co-
operate in
Lighthouse
service.

service. Those means consist,—1st, in its numerous and accomplished hydrographic staff, both at home and abroad, by whom all questions or disputed points as to the best position for a light could be settled, not only readily, but beyond doubt;* 2ndly, in its present complete chainwork of Coast Guard stations and flotilla, under intelligent naval officers at every point of the coast, as shown by the Coast Guard Chart, supplying as our Coast Guard does a perfect machinery not only for aiding in carrying out the Lighthouse service on shore and afloat, but one that could be employed in that frequent nightly inspection of the lights which we have reason to believe is absolutely necessary to the incessant maintenance of the best flames †,—a local *surveillance* which in France is secured by the superintendence of the *Ingénieurs des Ponts et Chaussées* resident in each *Département*, and to a certain extent in Scotland by the frequent professional visits of the Sheriffs of the maritime counties to the neighbourhood of the locality in which the Lighthouses are situated, during which they are in communication with people of all ranks, and have an opportunity of hearing their views, and of informing themselves of the condition and management of the Lighthouses, &c., under their charge; whilst in England the machinery for this purpose is to be found ready to hand in the present organization of the Coast Guard service; and 3rdly, employing, as the Admiralty occasionally does in the refuge harbour and other great naval works, some of the ablest engineers in this country, including the present engineer of the Trinity House and the engineers employed by the Scotch Board, it has at its command precisely that body of men whose estimate for a work, when once submitted, would scarcely admit of the dispute which continues to retard the lighting and marking a serious danger in a frequented sound on the west coast of Scotland.‡

39. On the other hand, we have the Board of Trade, a department having the general superintendence of matters relating to merchant ships and seamen, and which, since the passing the Merchant Shipping Act, 1854, has had the control over the three General Lighthouse Authorities, and in its six years' exercise of that control, much valuable experience must have been gained; it also the department at present representing the Lighthouse Authorities in Parliament,—it has—so far as the means at its disposal admit,—devoted the utmost attention to Lighthouse business, and has most scrupulously checked all Lighthouse expenditure; whilst, under the system as now proposed, the Board of Trade would have one of its professional members an ex officio member of the new Central Board.

Board of Trade
present con-
trolling authority
and
represents in
Parliament.

40. But whilst entertaining the question, which of the two, the Board of Trade or the Admiralty, is the fitter department to represent the Central Board in Parliament, and in considering the means, as above stated, at the disposal of the Admiralty for assisting in the Lighthouse service, it may be alleged that the Admiralty is already overburdened. In reply, I can only say that, if the Trinity Commissioners for Lights are well selected, such aid as would be required of the Admiralty would add very little to the present duties of that Board. Those branches of the Admiralty Office, viz., the Hydrographical, the Harbour Branch, and the Director of Works, upon whom the Lighthouse business, consequent upon co-operating in the Lighthouse service would devolve, are at present in the almost daily exercise of some of the details of that business;§ the

Small additional duty that would devolve on Admiralty if selected to represent Lighthouse government in Parliament, and to aid in our Lighthouse service.

* The sum voted by Parliament for the surveys of the current year in which the Naval Surveying Officers are engaged is 98,983*l*. 16*s*.

† It would have been of the utmost service if it had formed part of the duty of the Inspecting Commander of Coast Guard at Whitby to have instructed the officers under his orders to inspect nightly, and report upon the height of the flame now being maintained in the Whitby South Lighthouse since the important change that has been made in the lamp there. Since the above was written "Capitaine de Frégate" L. Foillouy, in an able pamphlet entitled "Reflections on the Navy" recommends the establishment in France of a Coast Guard similar to the English, and he proposes that the Commanders of this force shall have the Lights and Beacons of their Sub-divisions under their control.

‡ In April 1859, the estimate for a lighthouse in the Sound of Jura, on the west coast of Scotland, was objected to, *the plans being entirely approved*; the objection is still maintained, and the lighthouse is not yet commenced.

§ See (for example) the case of the Lighthouse on Cape Pembroke in the Falkland Islands, referred to by Mr. Alexander Gordon, C.E., page 646, Vol. II., in answer to Questions XXI. and XXII., "*Mariners' Questions*" issued by this Commission.—*Appendix to Report*.

A complete List of the Lighthouses of the United Kingdom, with the order and character of each light, is annually published by the Admiralty; and it is the Hydrographer of the Admiralty who sees to the placing of those lights in their proper positions in all official charts, viz., those which bear the stamp of the Hydrographic Seal of the Admiralty; whilst no List, as far as we have been able to ascertain, emanates from the Board of Trade, or either of the Lighthouse Boards, who would appear to be the only responsible authorities in the matter of lights.

N.B.—Since writing the above, a letter has been received from the Admiralty—in reply to questions put by this Commission—strongly illustrative of the remark "*that the Admiralty is already in the almost daily exercise of Lighthouse business*," and not only as above stated, "*irresponsibly*" engaged, but to an extent, and in a manner that even with my acquaintance with Admiralty business, I was scarcely aware of. It furnishes an example also of a rather rotatory process. It will be seen from that letter that *the Admiralty* publishes the official List of Lights; but the Admiralty is in a great measure dependent for its accuracy as

Admiralty is at present referred to, and frequently consulted by the Trinity House in Lighthouse matters—but irresponsibly, whereas if the Admiralty were selected for the representing body, it would be affording statutory as well as material aid; and, in affording such aid, I am persuaded that no increase of staff would be required at that office. Some additional duty would devolve upon the Comptroller-General of Coast Guard, whose officers would, for purposes of inspection, and for telegraphing casualties to the Lighthouse offices, in each capital, be placed in communication with the Lighthouses and Floating Lights along the coast; but with the Comptroller-General of Coast Guard as an ex-officio member of the Central Board, the Admiralty would have little, if any, additional work. The Comptroller-General of Coast Guard and the Hydrographer of the Admiralty would have the readiest means of satisfying themselves as to the reasonableness of any requisition that might be made on the Admiralty, and it would be only necessary for these officers to report to that Board, and it would issue its orders accordingly. Such requisition, however, would not be frequent; as the supply of stores, the changing the crews of lightvessels, the shifting of buoys and lightvessels, the periodical inspections by the Inspectors of Lights, &c., would be effected as at present by vessels specially employed for those purposes under the superintendence of the proper officers of the Central Board, excepting where any of those services could be performed with advantage by the steam gunboats and the sailing tenders attached to the Coast Guard.

41. Leaving it then an open question, whether the Board of Trade or the Admiralty is for the future to represent our Lighthouse Government in Parliament, and, reverting to the unanimous opinions of the several Parliamentary Committees, embodied as those opinions are in the recommendation of the Committee of 1845, viz.: "*That all expenses for the erection and maintenance of Lighthouses, Floating Lights, Buoys and Beacons on the coast of the United Kingdom be thenceforth defrayed out of the Public Revenue,*"—and assuming that the time is not far distant when the present ex-officio necessity for the Board of Trade being the representative in Parliament of our Lighthouse Government will naturally cease,* it might not be unnatural that the Admiralty, as able materially to co-operate in the Lighthouse service, should be selected to represent that service in Parliament, in which case the duty of such representation would devolve upon a department with which the Trinity House has from the first had real affinity, whilst we should at the same time be assimilating the Lighthouse government of this country to the systems most generally adopted abroad.

42. Supposing, then, for the moment, that the Admiralty were the department selected for statutory connection with the new Lighthouse Board, a positive additional duty would, to a certain extent, devolve upon that member of the Board of Admiralty who would have to present the Lighthouse Estimates to the House of Commons; but those estimates would be of the simplest character if framed in the admirable form in which the Navy Estimates are now prepared for the House of Commons by the Accountant-General of the Navy; and so framed, the Lighthouse Estimates would be such as any one accustomed to the Navy Estimates would be able to master in half an hour.

regards that List on the Board of Trade—it sends its proof sheets for correction to the Board of Trade, and they come back to the Admiralty to be published. Again, the Admiralty relies on the Board of Trade for immediate information on an alteration taking place in any existing Light, Home or Colonial, or in the case of a Home Light only, on the Trinity House; and it is the Admiralty that forthwith issues a printed Notice to Mariners distributing at once from 700 to 1,000 copies.

In addition to the above mode of obtaining information, the Admiralty endeavours further to obtain it through its own surveying officers; and in the General Naval Instructions now under revise, special directions are inserted as to Captains reporting on Lights to the Admiralty. It is also at the request of the Admiralty that circulars have been issued to all British Consuls abroad, desiring them to report alterations in Lights in their several consulates; whilst the preparing and printing "the Notices to Mariners" respecting Lights, must form a very considerable item in the business of the Hydrographer, to say nothing of the labour devolving on his department in insuring that every new Light shall be immediately inserted in every Admiralty Chart. (See also Admiralty Circular to Chart Agents, dated Hydrographic Office, Admiralty, 6th of February 1861, Vol. I. p. 225.)

* Whilst in this country, where we have 404 Lighthouses and Floating Lights (general and local), every foreign vessel has to pay light dues,—in America, where there are also upwards of 400 Lighthouses and Floating Lights, no charge whatever is made on British ships. In France it is the same, though it should be stated that in that country the port charges, which are heavier than in ours, are made to contribute to Imperial funds, and may fairly be said to include these dues; nor are any charges for lights made on British ships entering any of the ports of Russia, Prussia, Holland, &c. (See "*Our Merchant Shipping, its present state considered (and Appendix)*," by W. S. Lindsay, Esq., M.P.)

N.B.—We have it stated that on the 1st November last, the New York Chamber of Commerce accepted a report made by the Chairman of the Executive Committee, which, amongst other conclusions come to, contained the following:—

"6. *Coasting Trade.* The Committee see no objection to discussing in the Chamber the propriety of throwing open to British Shipping the Coasting Trade between the Atlantic and Pacific Ports, it being understood that Great Britain would reciprocate by abolishing "LIGHT DUES," "passing tolls," "local charges," "compulsory pilotage," "colonial coasting," and "intercolonial trade," and "the coasting trade of the American lakes."

Open question whether Board of Trade or the Admiralty should represent in Parliament.

Lighthouse estimates easy to be understood.

43. In the case of the Board of Trade, this duty is already performed (though the estimates appear at present in a somewhat meagre shape) by the representative of that department in the House; and in either case, and considering that officers from each of those Departments would form (ex officio) part of the New Lighthouse Board, the member presenting the estimates to Parliament would have ample means of acquiring every information respecting them, and having obtained for himself such information, and once in a position to explain those estimates to the House, the financial control (or, as the President of the Board of Trade describes it, "*the Control of the Purse,*") on the part of the representing Department should cease.

Facilities at hand for either the Board of Trade or the Admiralty explaining the Lighthouse estimates to the House of Commons.

44. The state and condition of our Lighthouses, and the effectiveness of the lights themselves, admit of favourable comparison with the great mass of lights and lighthouses abroad, with the exception of some of the lights in France; but there is room for improvement, and the existing system is scarcely the most favourable for that improvement: under this system the control and management of our Lights has passed into the hands of the Government, but as matters stand there is no department of the Government which possesses machinery fit for the purpose; the Board of Trade is at present the governing body, and it is in the actual exercise of functions which, as that department is now constituted, it is scarcely equal to, or was probably intended to fulfil; at the same time, it must be admitted that even before the application of such control, the progress of our Lighthouse Authorities, at least in England and Ireland, whether in Lighthouse science or management, had scarcely been in keeping with the state of science in this country; but with a central Board, as now proposed, and in itself responsible, improvement might be expected, and it ought in its management to keep pace with the times.

Lighthouse system capable of improvement.

Anomaly in present system of Lighthouse government. Lighthouse science and management would probably advance under proposed scheme of government.

45. "*The great safeguard of human life on our coasts is the lighting up of our reefs and headlands, and this can be accomplished only by Public Boards, composed of qualified individuals, and possessing ample resources and extensive jurisdiction.*"* In a Central Board of eleven members, composed as has been suggested, there can be no doubt that we should have a body fit to manage its own affairs, without that description of check and control which is now exercised over the three Lighthouse Authorities; and we may feel satisfied that in estimates which would be prepared under the superintendence of such Central Board, the strictest regard would be had to the economical and just application of its funds consistent with the one paramount object of the proper Lighting of our Coasts, and in maintaining in the utmost efficiency our National Lighthouse system, and it may be presumed, that those great interests,—the interests of Humanity, of Navigation, and of Commerce,—which our Lighthouse Government is intended to serve, would be best promoted by providing that the Lighthouse Estimates should be presented to the House of Commons, as prepared by the Trinity Commissioners for Lights, to be dealt with by Parliament, as is the case with other estimates coming before it.

Central Board to have control over Lighthouse expenditure.

46. In conclusion I need hardly remind my colleagues of our numerous and anxious conferences on the subject of Lighthouse management and control, and that it has been by a sort of exhaustive process that the scheme of Government above proposed has been arrived at; nor need I now allude to our long and careful investigations,—the many experiments we have ourselves originated, and in great measure conducted; nor to that constant and anxious consideration which we have given to this portion of our inquiry.

Course by which alone conclusions have been come to.

Summary of proposed Government.

To sum up the above proposal.—The GOVERNMENT and MANAGEMENT of Lights, Buoys, and Beacons in the United Kingdom, and of certain Lighthouses in the Colonies, should be vested in a new Central Board (constituted as already stated), and to be denominated the TRINITY COMMISSIONERS for LIGHTS, subject to the annual visitation of THE ROYAL SOCIETY;—the BOARD OF TRADE or the ADMIRALTY to be the Department that would present to Parliament the Lighthouse Estimates, as prepared by the Trinity Commissioners; whilst, as regards expenditure, after those estimates have passed the HOUSE OF COMMONS, THE CENTRAL BOARD should have the entire CONTROL.

Summary.

* British Lighthouse System, by Sir DAVID BREWSTER, LL.D., F.R.S., Principal and Vice-Chancellor of the University of Edinburgh.

May 1867. Returned to this old subject
after about six years and came to
the conclusion that we might
have made a much better job
of the report if any one of us
able to write English had
been allowed to put the
opinions of the Commissioners
into language, and to
arrange the subject under
heads. as it is too many Cooks
as usual spoiled the broth.

But inasmuch as a blue book
is a plane of decent burial for
knowledge it does not matter
a row of pins what this
report is like. as Secretary I
worked till I used to come home
exhausted & sleep on the rug. I
know that I deserve what is said
at page xlii at least but
to what end was all this labour.

I alone have got neither prize nor
profit unless the prize otherwise
conceded with knowledge gained at this
work. J. F. C. Secy.

APPENDIX.

ELECTRIC LIGHT, &c.—CRUIZE OF THE “VIVID.”—FOREIGN INSPECTIONS.—INSPECTIONS OF APPARATUS AT HOME AND ABROAD.—PAPERS BY MEMBERS.—LETTERS FROM THE ASTRONOMER ROYAL.—PROFESSOR FARADAY’S REPORTS.—OBSERVATIONS BY MR. JAMES CHANCE, MESSRS. D. AND T. STEVENSON.—ABSTRACTS OF EVIDENCE, &c., &c.

29th April 1859. 31st Meeting.

PRESENT,

Admiral Hamilton, Mr. Graves, Dr. Gladstone,
Captain Ryder.

Mr. ALLEN attended, and stated that the Magneto-electric light would not be exhibited after Monday night at the South Foreland.

At 4.30 the Commission decided to visit the South Foreland, and adjourned, in the first place, to Adam Street, Adelphi, to inspect a lime light.

The light is on the same principle as Drummond’s, but varies in the shape of the prepared lime on which the oxyhydrogen blow-pipe flame plays, and it has also three jets instead of one. The prepared lime is pushed slowly upwards as it is worn away by the heat, and is prevented from falling outward by a series of wires.

The light was brilliant and steady. The French Superintendent of the Light House Board, Mons. Rénaud, was present, and he, as well as many other gentlemen, expressed admiration of the light.

Mr. Graves, Dr. Gladstone, Captain Ryder, and the Secretary started from London Bridge at 8.30 p.m. Dr. Gladstone, on arriving at Dover, proceeded to the South Foreland, while the others embarked for Calais, and observed the electric light from the steamer. (*Dr. Gladstone’s report follows.*)

The light was far brighter than any of the others, visible either on the French or the English coast.

It was steady. It seemed to be obscured for a time twice during the passage, but it subsequently appeared, from Dr. Gladstone’s report, that the seeming obscuration might, (as was suspected,) have been caused by the passage of the steamer through the shadow of one of the bars of the lantern. No alteration in the light was observed by Dr. Gladstone, who was at the light house, but the shadow of the bars were clearly visible in the air close to the light, and must have obscured it at a distance.

From Calais the electric light appeared like a large star on the horizon, with a bluish tinge, while the lower South Foreland light,—catoptric, oil lamps,—though clearly visible was less bright, and yellow, or rather orange.

The sailors on board the steamer estimated that they could see the electric light for 30 minutes after losing sight of the lower light. That is, according to the rate of the steamer, at a distance of about 7 miles.

They had seen it in thick weather when the other was invisible.

The light at Griseval, as seen from Dover, was about equal to the Lower South Foreland Light, as seen from Calais.

The electric light, at a distance of some miles, threw a shadow which could be seen clearly on the palm of the hand, and still more clearly on a white surface.

With respect to coloured lights, it was observed that a blue light at Dover was lost when the common town lamps became invisible; that a white light at Calais Pier was first seen, next a red light, and lastly a green.

With respect to the colour of lighthouses it was observed that the lighthouse against the sky was difficult to make out clearly, when the lower lighthouse against a dark background of grass was easily made out; both are white. That the dark shadow inside the lantern, seen through the glass of the Upper Lighthouse, was better seen than the white wall against the sky as a background, and that the dark part of the Lower Lighthouse at the same time was invisible, while the white wall was clearly seen against the grass.

It appears to follow,—

1st. That the electric light should be fully tried, and that on its success should depend a consideration of its application to certain points of the coast.

2d. That red and green are better colours than blue, but that white is more powerful than any colour.

3rd. That lighthouses and beacons and buoys should be coloured with reference to the background against which they are seen.

The Commissioners visited the South Foreland Lighthouse after landing at Dover, and were much pleased with its condition, and with the intelligence and neatness of the keepers.

They inspected the electric light and the apparatus by which it was produced. They conversed with Professor Holmes, who explained the working of his apparatus and they afterwards returned to London by the 12 train.

Dr. GLADSTONE reported:—The principle of the Magneto-Electric Light is as follows:—The power that produces the light is resident in a large number (360?) of permanent magnets ranged on the periphery of two large wheels. This power is called into action by a steam engine of two-horse power, which causes a series of soft iron cores surrounded by coils of wire to rotate past the magnets.

The small streams of electricity thus generated are collected together into one stream, and, by a special arrangement, the alternate positive and negative currents are all brought into one direction. The whole power is then conveyed by a stout wire from the engine-house to the lighthouse tower, and up into the centre of the illuminating apparatus; there it passes between two charcoal points, producing thus a most brilliant and continuous light. The “lamp” is so contrived that by means of clock-work and a magnet, round which the wire coils, the charcoal points are kept always at a proper distance apart. The charcoal lasts three hours, after which the “lamp” has to be changed, but the transition of the current is instantaneously effected, and the light is brought into the focus within ten seconds. The attendant can judge of the position and brightness of the light by watching where one of the luminous beams is thrown on the inner wall of the lantern, and thus he is seldom required to look at the brilliant spark itself. As arranged in the centre of the large dioptric apparatus at the South Foreland, the electric light gives scarcely enough divergence, and dark shadows are cast by the framework of the apparatus and lantern, notwithstanding a special contrivance of reflectors partially to obviate this, but from the luminous point being so small, and no draft of air being required, nor any soot or smoke being produced, it is evident that an arrangement of lenses, prisms, or of reflectors, might be made in a very small space, and perhaps the difficulty of the frame-work might be entirely overcome. The working expense of the Magneto-Electric Light consists of the coals consumed, and the charcoal points, with the wear of the machinery, and the wages of an engineer in addition to the ordinary light-house keepers.

At a distance of one or two hundred yards the magneto-electric light appeared incomparably more brilliant than that exhibited by the lower lighthouse, which is fitted with fifteen parabolic mirrors kept apparently in the highest state of polish. Dr. Gladstone remarked the great cleanliness and order observed in the lower as well as the upper lighthouse.

The electric light appeared of a bluish white in comparison with all other artificial lights in view, caused a

Conclusions.

Observations by Dr. Gladstone

Engine.

Divergence.

Reflectors.

Lenses.

Cost.

Brilliancy.

Comparison.

Electric Light. remarkable fluorescence in the glass of the apparatus, and illuminated the atmosphere in such a manner as to produce singular optical effects, both near at hand and at a distance.

Observations by the Chairman, Admiral Hamilton. Admiral HAMILTON visited the South Foreland lighthouse on the night of the 4th of May, arriving at the light at 9 p.m., and quitting at 11.30 p.m. Professor Holmes was on the spot, and explained minutely the principle of the magneto-electric light, and all the details of the apparatus. It appeared that there was the greatest facility in managing the light, and that very common care was required to insure its regular exhibition. During Admiral Hamilton's stay at the light it was visited by a pilot, an intelligent young man (by name Goldsack), who had had constant opportunity of observing the light from the Channel since its exhibition, and who bore strong testimony to its great brilliancy and efficiency, and greatly regretted its contemplated removal. In this regret Admiral Hamilton cordially joins; for it would seem to be a waste of money now that the whole machinery is working well to extinguish the light without a further opportunity being afforded of testing its merits as compared with other lights. Admiral Hamilton cannot but be of opinion that a fuller opportunity and more extensive means, not only of testing the working of the light, but of enabling mariners to judge of its efficiency, and to make their comparisons with respect to other lights, should be afforded. He understands that Professor Faraday has reported on the magneto-electric light to the Elder Brethren of the Trinity House, and he considers it would be right that this Commission should request to be favoured, as early as possible, with a copy of that report, in order that such steps may be taken as the Commissioners may deem fit, with a view to a further trial of the light, it being reported to the Commission that it is intended to remove the whole apparatus immediately. Admiral Hamilton also visited the Lower South Foreland Lighthouse, returning to Dover at 12.20 (night). The light (magneto-electric) was observed from Dover pier, at 12.30. Admiral Hamilton returned to town next morning. He was much struck with the cleanliness and perfect order of the North and South Foreland lighthouses, and the manner and intelligence of the lighthouse keepers.

Evidence.

Observations.

Conclusions

On the 6th of May the secretary was directed to write the following letter:—

SIR,

May 6th, 1859.

Correspondence.

I am directed to request that the Commission may be furnished with a copy of the Report which has been made by Professor Faraday on the magneto-electric light at the South Foreland. The Commissioners have themselves observed the light. They have received returns from pilots and others relative to it, and assuming that Professor Faraday's report is favourable, they are anxious to be informed of the decision of the Elder Brethren relative to the electric light. They wish to be informed whether the Elder Brethren contemplate adopting the principle of the light by applying it to certain lighthouses on salient points of the coast, or whether they intend to make further trial of the light by continuing to exhibit it at the South Foreland for a further period, under the entire management of their own servants, or whether they intend that the machinery for producing the light shall be removed from its present position.

I am, &c.

J. F. CAMPBELL.

P. H. BERTHON, Esq.

On the 12th, reply of the Trinity House was read:—

Trinity House, London, E.C.,

SIR,

12th May 1859.

Having laid before the Elder Brethren your letter of 6th instant, signifying the request of the Commissioners on Lights, &c., to be furnished with a copy of Professor Faraday's Report upon the Magneto-Electric Light at the South Foreland, and with information as to the probable adoption of the light by this corporation, I am directed to acquaint you, for the information of the Commissioners, that not having received from Professor Holmes certain particulars which he has been requested to furnish, and which the Elder Brethren consider essential in the consideration of the question as respects the practical applicability of the light to lighthouse purposes, they are not yet in a position to comply with the Commissioners' request.

I am, &c.

J. F. Campbell, Esq.,
&c. &c., &c.

P. H. BERTHON.

On the 8th of November the electric light was again observed from Boulogne, and previously, on the 5th of November, the Commission were present, at Paris, at certain experiments instituted by the French Lighthouse authorities for the purpose of testing an electric light. See page 38.

It was stated that the lighthouse keepers on the French coast had been instructed to observe the light at the South Foreland with great attention.

An abstract of the evidence of mariners as to the South Foreland will be found at page 114.

On the 26th of November, the following Report from Professor Faraday to the Trinity House was received by the Commission, and confirms their views expressed above.

REPORT

ON

THE MAGNETO-ELECTRIC LIGHT ESTABLISHED
BY PROFESSOR HOLMES AT THE HIGH
LIGHTHOUSE, SOUTH FORELAND.

Royal Institution,
29th April, 1859.

Professor
Faraday.

The light applied in the South Foreland Upper Lighthouse is an electric light; not produced, however, by a voltaic battery, but by magneto-electric induction. In the year 1831* it was discovered that when a piece of soft iron, surrounded by a metallic wire, was passed by the poles of a magnet, an electric current was produced in the wire, which could be exalted so as to give a spark. The apparatus of Professor Holmes, which is figured and described in the accompanying paper A, consists of an accumulation of powerful magnets and iron cores with surrounding coils, accurately arranged, so that when the associated cores are revolving they send all their currents into one common channel, from whence they are conveyed to the lantern by conducting wires, and there produce the electric light. There is no consumption of material or energy, other than that of the burning fuel required at the steam-engines to produce motion.

A trial of the light began in the lighthouse on the 8th December, 1858; but as the apparatus was imperfect in some points and the results unsatisfactory, the lighting by the apparatus was suspended for a while, that the defects might, if possible, be remedied. The lighting was renewed on the 28th March instant, and has been continued regularly since.

I have had the honour of accompanying the deputy master and brethren, both on the former and present occasion, so that I know personally what the light *was* and *is*. No report was made at the former time, because of the expected improvement of the arrangement; but it now becomes my duty to report on such matters regarding the lamp as properly fall within my province.

Being on board the yacht off Dungeness on the night of the 20th inst., about 21½ miles from the South Foreland, the weather being rainy and the sky covered with clouds, we could see (when the sun went down) the high light illuminated and appearing as a faint star. I could not perceive the low light; but proceeding eastward the low light gradually became visible, and the high light increased in brightness. When about S.W. by S. the yacht approached the lights more directly; then went eastward again, and after awhile turned and proceeded towards Dover; so that the observations were made through about one-fourth of the horizon, and at very different distances from the South Foreland. From the time the upper light was first seen until the last, it remained visible and *steady* (with the exceptions to be mentioned immediately), and much superior to the lower light when that also came in view. The exceptions were as fol-

* Philosophical Transactions 1832, p. 131, Faraday.

lows:—At times the high light fell off, and once appeared almost out, when the lower light underwent no such change. This effect had been anticipated, and was due to the following cause:—the upright bars of the lantern windows and the dioptric apparatus are much broader than the electric light, the latter being, indeed, not more than one-sixth of an inch in horizontal width; hence they throw deep and rather sharp shadows. By taking the bearings of these beforehand, it was found at sea, that the falling off of the light coincided with these shadows, and hence the above exceptions. The evil occurs in part with the central oil lamp, and is in some lighthouses partly remedied by causing the window bars and astragals to incline from the perpendicular, and therefore out of the plane of refraction. Other remedies (in addition to this) are applicable in the case of the electric light, and in the present instance the effect is lessened by the use of a small reflector at the lamp, close to and behind the light. The light was at all times white, or even blue occasionally, in comparison with the low light, which appeared yellow or reddish.

The next day I examined the lighthouse and apparatus both by day and night. The magneto-electric machines, steam engines, and steam-condensers were generally as at the last visit. In respect of the commutator it had worn very little; the application of a file to the surface of one wheel had removed about the thirteenth of an inch of metal since the apparatus was first erected, there remaining about $1\frac{1}{2}$ inches still ready for consumption in like manner, if needed. During the daytime I compared the intensity of the light with that of the sun, *i.e.* it was placed before and by the side of the sun, and both looked at through dark glasses; its light was as bright as that of the sun, but the sun was not at its brightest, and was only seen at intervals between clouds.

In the lantern, there was now but one electric lamp in place, two others, however, being on the wire rails ready for change of lamp at any moment. The magneto-electric machines were set in action, and the lamps were manipulated with, both by day and night, to my entire satisfaction. When the steam engines were ready for action the machines could be set in motion, and the current evolved within the space of half a minute; the lamp could then be lighted in an instant, and if it were required to put out and displace that lamp and replace it by another, the operation could easily be performed by one person within 10 or 15 seconds. The light may be considered as at its full intensity at once, though it was reported to me as growing up in power until about four o'clock in the morning, an effect probably due to the continued recurring inductive action in the cores and coils of the revolving apparatus.

The place of the light in respect of the dioptric apparatus is exceedingly well retained, even more so than in the case of a lamp flame, which, though its base be fixed, varies in its height. The light itself is not that flickering, wavering, revolving light produced by the voltaic battery, but, in a sheltered atmosphere, as in the lantern, is fixed in its position; a fact of great importance in the application of small catoptric or dioptric apparatus. An important regulator of the character of the light is given by two magneto-electric coils introduced into the circuit in the lantern. The light does not call for continued attention, but is often left untouched for one, two, or even three hours together. The eyes of the keepers are not affected, though the blue glasses provided for them are very pale in colour, for the light is better watched by observing the *place* and *intensity* of the rays which fall here and there on the walls of the lantern, than by looking at the light itself.

On going out to the hills round the lighthouse, the beauty of the light was wonderful. At a mile off the apparent streams of light issuing from the lantern were twice as long as those from the lower lighthouse, and apparently three or four times as bright. The horizontal plane in which they chiefly took their way made all above or below it black. The tops of the

hills, the churches and the houses illuminated by it, *Electric light*, were striking in their effect upon the eye.

All the reports which have come in from the surrounding lighthouses, floating lights, and pilot vessels, confirm the superiority of the upper light above the lower, though many of the reports are imperfect. Those from Dungeness are the best; and include 160 observations made between March 28th and April 16th. The upper and the lower South Foreland and the Grisnez lights were either visible or invisible from the station, according to the weather. The upper South Foreland was visible first and oftenest, *i.e.* *always* if the others were; then the Grisnez came oftenest in sight; and then the lower South Foreland; but these were nearly equal. The Grisnez was sometimes in sight without the lower South Foreland, but never without the upper; and the lower South Foreland was sometimes in sight without the Grisnez. Upon the 160 observations there were 73 on which none of the three lights were visible; 86 upon which the upper light was visible; 40 upon which the lower light was visible, and 44 upon which the Grisnez light was visible. When both the upper and lower lights were visible, the upper (except in four cases) is said to be twice the power of the lower; in the four cases it is called equal. There was one exception on April 3rd at 10 o'clock p.m., when the upper light is stated to have *gone out*. The report does not say whether it came in again, but the weather at 11 o'clock is returned as very thick and misty. Generally the light is said to be very steady.

The keepers at the Goodwin and South Sand head floating lights appear to have had a fair view of both upper and lower lights. If both were visible, the upper was much the most powerful; the upper was always visible. The lights were generally very steady; if wavering, both the upper and lower wavered at the same time, as if the cause were in the air, not in the lights. The reports from the Gull Stream Light are very poor and afford no instruction. There is no comparison or mention of the upper and lower lights.

In fulfilment of this part of my duty I beg to state that, in my opinion, Professor Holmes has practically established the fitness and sufficiency of the magneto-electric light for lighthouse purposes, so far as its nature and management are concerned. The light produced is powerful beyond any other that I have yet seen so applied, and in principle may be accumulated to any degree; its regularity in the lantern is great; its management easy; and its care there may be confided to attentive keepers of the ordinary degree of intellect and knowledge.

There are many considerations, beyond the establishment of the fitness of the light in principle and management for lighthouse purposes, regarding its introduction into lighthouses generally, on which I should hesitate to speak before those who are far more competent to judge of these matters than I am, were it not for the encouragement which the Brethren of the Trinity House give me, and especially as regards *this light*, in respect of a letter from Professor Holmes dated 28th April 1857, which I considered in my letter of the 1st May. I will, therefore, venture to enumerate some points which are *against* and others in *favour* of the light, and of a change in the present system. In the first place, the simplicity of the present system is very great compared with that of the electric light. Only two keepers are required to a lighthouse, they need possess no special knowledge, ordinary attention is all that is necessary; and thus failures of the light are almost impossible. In the new system a second set of men will be required to attend the engines; and there must be amongst them one or more who understand the principle and construction of the lamp in the lantern, of the magneto-electric machines, the steam engines, and the condensers below, and be able to make *effectively* the repairs necessary to the apparatus; or, as I think is more probable, a competent resident intelligent engineer, with his stock of tools and means, will be required.

Electric light.

In the next place, the expense of the new system must be large, compared to that of the present system. As *outfit*, there must be the cost of the two if not three magneto-electric machines, with the corresponding steam engines ; of the houses to contain them ; of the cistern, condensers, and water apparatus, and supply associated with them ; of the electric lamps in the lighthouses, with their connexions ; and of the lodging houses for the extra men. And in respect of *current expenditure*, additional provision must be made for the wages of the extra men, with coals and such things as are allowed them ; the fuel for the engines ; the supply of water ; and the repairs required by the wear and tear of all the apparatus. To these causes of expense must be added the claims of the Patentee. In the matter of expense for any given amount of light, I may say that the letters I have already referred to of the 28th April and 1st May 1857, can scarcely be accepted as giving sufficient information. I conclude that by this time Professor Holmes is in a position to give an amended statement.

Amongst partial objections it may be stated that the light cannot be expected to apply to *all* lighthouses, or receive general adoption. I am not aware how many it might be fit for ; but there are evidently some at extreme situations where it would be objectionable in its present state. An objection has also been made, of which I cannot see the force ; namely, that the light is too bright ; that it gives a false impression of the distance of the lighthouse, and that it blinds the eyes of the mariners to the perception of the lights on board vessels between it and them. These objections, if they have any force, must be judged by mariners themselves.

The points *in favour* of the magneto-electric light, now that its practicability has been established, are strong and clear in relation to the increase of light and the advancement of lighthouses in power. In cases where the light is from lamp flames fed by oil, no increase of light at or near the focus or foci of the apparatus is possible, beyond a certain degree, because of the size of the flames ; but in the electric lamp any amount of the light may be accumulated at the focus and sent abroad, at, of course, an increased expense. In consequence of the evolution of the light in so limited a focal space, it may be directed seaward, diverging either more or less, or in a vertical or horizontal direction, at pleasure, with the utmost facility. The enormous shadow under the light produced by the oil flame burner, which absorbs and renders useless the descending rays to a very large extent, does not occur in the magneto-electric lamp ; all the light proceeding in that direction is turned to account. The optical part of the arrangement, whether dioptric or reflecting, might be very small in comparison with those in use. It is probable that the system either of reflectors or refractors need not be above 18 inches in diameter, perhaps much less, and probably a foot high. The glass of the lantern through which the rays would pass would then not require to be above 12 inches radius, *i.e.* from the light. This would allow that part of the lantern to be constructed of carved plates of glass, framed above and below, and requiring no opaque, intervening, shadow-making uprights. There appears no reason why such a lantern should not enclose the electric lamp round seven-eighths of the horizon, and yet allow of all necessary attendance on, and change of the lamps. Such arrangements, however, could only be made when the lamp is (if ever) perfectly established ; for they would preclude the substitution of an oil lamp for the electric lamp, if any accident occurred to the latter.

Before concluding this report, I must bear my testimony to the perfect openness, candour, and honour of Professor Holmes. He has answered every question ; concealed no weak point ; explained every applied principle ; given every reason for a change either in this or that direction, during several periods of close questioning, in a manner that was very agreeable to

one whose duty it was to search for real faults or possible objections, in respect both of the present time and the future.

(Signed) M. FARADAY.

July 16, 1860. — The Chairman and Secretary visited the establishment of Mr. Holmes at North Fleet, and saw the electric light, as shown in the regulating lamps of Monsieur Serin. The light was extinguished and lit instantaneously at various points, by breaking and making the contacts. The invention appeared to work exceedingly well. Mr. Holmes appeared to be engaged in the construction of various forms of reflectors, and it was suggested that he would do well to apply for advice to Sir John Herschel. It was stated in conversation that the electric light is to be set up shortly at Dungeness. Mr. Holmes also stated that Mr. Chance was engaged in constructing a dioptric apparatus according to calculations, furnished in the first instance by Mr. Holmes, subsequently calculated by Mr. Chance. The apparatus is intended "to throw the light where it is wanted," and each prism and angle is to be specially ground for the light. See page 34, and oral evidence.

PROFESSOR WAY'S ELECTRIC LIGHT.

On the 13th of May, 1859, the following minute was made by Dr. Gladstone :—

Professor Way's light.

In the evening the Commissioners visited Professor Way, and saw his electric light. It is produced between a running stream of mercury and a small cup full of the same metal ; the whole being comprised within a stout glass cylinder, cemented into brass-work, which screws on to the apparatus, so that the whole is hermetically sealed, and the volatilized mercury is condensed again in a long tube under the cup. The power is generated by a galvanic battery of 48 Bunsen's cells, which requires renewal every four hours, and is said to cost 1s. 6d. per hour, though were the products economised and the nitric acid regained, Mr. Way believes a saving of one half might be effected. The light is continuous, and forms a kind of cone between the jet whence the stream of mercury flows and the cup beneath. It is intensely brilliant, casts a greenish blue radiance on surrounding objects, and has a most wonderful effect on artificial colours, its constitution evidently being widely different from that of solar light. Professor Way showed that the current might be interrupted frequently in succession, and that the light which on each interruption is extinguished re-kindles itself immediately contact is again made ; and suggested that this might be used as a method of economising the force, of distinguishing between different lighthouses or for signalling. The Commissioners viewed the light, not merely from Mr. Way's laboratory and house, No. 15, Welbeck Street, but also from Hinde Street and the corner of Manchester Square, when its great superiority over gas lights was most apparent.

This light was again shown to the secretary on the 29th of March, 1860, by Professor Way. The electric light had been shown that day to a scientific commission belonging to the War Office.

The light is produced in a stream of mercury flowing through slender tubes, and connected above and below with the poles of a powerful battery. By clockwork the connection can be broken and remade, and the light extinguished and relit instantaneously. It was very powerful, and of a peculiar ash grey colour, which gave a ghastly appearance to every person and thing in the room.

The light was said to reach its greatest brilliancy some time after the battery was filled, and to continue steady for a considerable time. After a certain time when the acids are saturated the light wanes.

One drawback to the light is that the force of the electric fluid scatters the stream of mercury into spray, and throws it against the glass within which the light is shown.

These drops of an opaque though fluid metal necessarily obscure the light, and settling on the glass interfere with its brilliancy.

When the glass is removed the mercury is changed into vapour, and becomes highly deleterious. A portable form of this light was shown. A small vessel of mercury within bronze cylinders, so constructed that by turning the apparatus the mercury is thrown back into the upper chamber.

Also a boat with a copper sole, intended to make and break the connection with a wire let into the deck of a ship, and joined to the battery below.

This light was exhibited at Oxford, and subsequently as a masthead light on board a vessel in the Solent, in July, 1860. An account of the proceedings was published in the "Times."

Memoranda made by Captain RYDER regarding a visit to the shop of Mr. Wilkins, Long Acre, Lighthouse Lamp Maker, June 24th, 1859.

Mr. GRAVES, Dr. GLADSTONE, Captain RYDER, the SECRETARY.

Mr. Wilkins accompanied us over his shop, and we saw the various parts of the illuminating apparatus of different lamps.

The lantern of a floating light under repair.—Mr. Wilkins stated that after seven years' wear and tear the lantern of a floating light requires a thorough overhaul. The paint is entirely burnt off the copper in order to examine it; the ventilators are taken out and refitted, and the lantern is made almost as good as new. A lantern with two such thorough repairs will last for 21 years.

We noticed that there were three sets of orifices for ventilation in the lantern, some underneath, some on the top, and some on the side. The size of these can be diminished at pleasure. In a gale of wind the upper holes have to be entirely closed, otherwise the lamp would be extinguished.

The reflectors are copper lined with silver, and their sections are parabolas. We saw some reflectors invented by Major Fitzmaurice made of china or porcelain. The inner surface was composed of platinum glaze; it was very wavy, and not very bright; but the reflectors were comparatively very cheap, being one quarter the price of the metal, and do not tarnish. The set we saw were for a small light on Major Fitzmaurice's principle, to range five miles.

We saw several lamps for floating lights; they hang on gimbles inside the lantern. All floating light lamps are thus hung, and are Argand lamps. The reflectors for floating lights last about 15 years. They are not considered to be worth re-silvering, but are broken up at the expiration of that time. The reflectors of lighthouses have more silver on them, and will last for 50 years. We were shown a metal reflector of three feet diameter for a lighthouse; its value was about 50*l.*, and Mr. Wilkins considered that for a revolving light such a reflector would be more efficient than a 1st order dioptric light. Its merits are to be compared with a 1st order dioptric light at the Trinity Buoy Wharf in a few days. When the light is obliged to be very high, as at Lundy, the reflectors are said to be slightly inclined to the perpendicular to throw the rays downwards; but the prisms are never inclined, but are always so adjusted in the first place as to throw the rays horizontally.

The position of the prisms is carefully tested by inspecting the direction the rays take, as shown by the position of the end of the pencil of light on the screen erected for the purpose, there are no adjusting screws to the prisms. Professor Faraday inspects the prisms, and they are moved in their beds of putty,

if necessary; the intended height of the lighthouse is never taken into consideration.

Mr. Wilkins has contracts for South America and the United States and Russia. The English metal work is much preferred for its solidity and toughness. Mr. Wilkins first said the French illuminating apparatus was cheaper, and then thought it was dearer than the English. He obtains his glass generally from Mr. Sauter, or Lepaute, of Paris, or Messrs. Chance of Birmingham.

Gas has been tried, but, in Mr. Wilkins' opinion, Gas has never succeeded as a substitute for oil.

Contracts.—All new lamps are contracted for as a general rule by one of the following four manufacturers, Chance, De Ville, Simpson, or Wilkins; of these Chance is the only glass maker. The contract is always nominally open and advertised for in the "Times." The tariff prices of these firms are exactly and by agreement the same. There is, therefore, no competition among them in dealing with the general purchaser, and I was unable to elicit from Mr. Wilkins any explicit statement that could satisfy me that even in tendering for contracts to the Lighthouse Board there was not an understanding between the firms. I think it will be advisable, therefore, to ascertain the dates of the several contracts entered into for illuminating apparatus since 1853, the names of the contractors, their several tenders, and the amounts paid in each case to the accepted contractor, to enable us to inform ourselves whether it is not probable that by a secret arrangement among themselves the contractors have divided the contracts, (a proceeding which it is, of course, perfectly competent to them to adopt if they choose,) and thus really enjoyed a monopoly. It is worthy of note, that although Mr. Wilkins and Mr. Chance are competing contractors, Mr. Wilkins frequently obtains his lenses and prisms of Mr. Chance, as he does not make glass himself; and Mr. Chance obtains lamps of Mr. Wilkins, as he does not make lamps; and that thus the unsuccessful contractor assists his successful rival to complete the contract.

The Irish illuminating apparatus, and, in some instances, the Scotch also, were ordered we were informed by the Board of Trade; but as a general rule the Scotch Board ordered their illuminating apparatus of Milne, of Edinburgh.

Experiments have been tried to illuminate a letter or figure, so as to enable the mariner to identify a light at night, but they all failed, for when a long slip 10 feet by 4 inches was illuminated, it appeared at any distance over two miles as a circular light.

Fog Signals.—We were shown a bell of 3 cwt., similar to that used at the Gunfleet, worked by machinery. The cost was about 240*l.* Bells as large as 12 cwt. have been made for this purpose for the Casketts.

Mr. Wilkins has supplied six in the last four years. A 3-cwt. bell is said to be heard at a distance of four miles in a thick fog.

Mr. Wilkins remarked on the orders of the Board of Trade, "that while that Board appeared most anxious to have the very best articles they were very desirous to obtain them at the lowest price."

ALFRED P. RYDER.

The Trinity Buoy Wharf was visited on the 18th June 1859, by Admiral HAMILTON, Captain RYDER, Mr. GLADSTONE, and the Secretary, and the following notes made by Captain RYDER.

The Trinity Yard and Buoy Wharf, situate on the mouth of the River Lea at Blackwall, comprises a space of from two to three acres.

Trinity Buoy Wharf.

It does not profess to be a manufacturing establishment, but rather a dépôt for buoys, and of stores of all sorts for the use of lighthouses and lightvessels.

A spare lightvessel is always at the wharf in readiness to replace any lightvessel that might be driven from her station, and for the purpose of undergoing the periodical repair.

Lightvessels are built and repaired at Messrs. Pilcher's yard.

The wooden buoys of the Trinity House are manufactured at Thos. Allen, Shuter, and Co., Dockhead, and the iron buoys at Messrs. Lennox, Brown, and Co.

The average number of men in the yard (being those on shore in their turn from the lightvessels) is 36; their average wages are 2*l.* 15*s.* per month, and they find their own provisions.

They are employed in receiving, storing, and issuing stores, including oil, and in transporting buoys, manning the Trinity House yachts, &c.

The whole of the oil for the entire service of the lighthouses and lightvessels is stored in this yard. The average quantity in store is 215 tons.

BUOYS.

Buoy Store.

The arrangements for examining, replacing, and repairing the buoys appeared to be very efficient.

Every buoy belonging to the Trinity Board, and there are more than 80 Buoy stations in the London district alone, which extends from North Foreland to Orfordness, is replaced by a spare buoy every six months, is brought on shore, thoroughly overhauled, repaired, and repainted; and then kept in perfect readiness to return to its station, either at the end of six months or on any accident happening to its companion. A large shed is full of these buoys, painted, marked, and ready to start for their stations at a few minutes' warning.

Classes of Buoys.

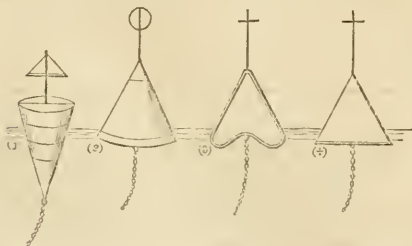
The buoys used by the Trinity Board may be divided into two classes.

(I.) The Nun Buoy, which is only used to mark wrecks, is painted green, is six feet in length (of stave), and about eight feet in total length, including the heads. It shows above water about five feet. It weighs about four or five cwt., and the coopeage costs about 9*l.*



N.B. In the Thames, owing to the great number of passing vessels, and their frequent collision with the wreck buoys, beacons on the nearest shore have been substituted, on which the position of the wreck is indicated, and the Trinity Board are also trying solid wooden buoys, with framework tops.

(II.) The Can Buoy, used to mark channels, shoals, &c.



No. (1) is the old can buoy, floating apex downwards but they generally float on their sides (the Admiralty still adhere to this shape). Within a few

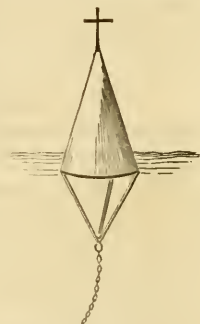
years the can buoy has been reversed by the Trinity Board, and the chain has been secured, as in Nos. (2), (3), (4), to the centre of the base.

No. (2) is a wooden buoy, hooped inside, a suggestion of Mr. Poulter, to prevent the rust from the hoops affecting the colour of the buoy. Its base is convex (1 in. in 12 in.) and the diameter of the base is equal to the height of the buoy. The largest buoys of this description are 8 feet in the stave, and about 9 feet 6 in. high. When floating, about 2 feet is immersed, leaving 7 feet 6 in. above the water. If this buoy was reversed, only about 5 feet of it would show above water. This buoy was designed by Mr. Poulter, the Superintendent of the Trinity Buoy Wharf, but he does not claim the merit of first suggesting the reversal of the can buoy.

Hooping the buoy on the inside adds very considerably to the expense of the buoy.

A Poulter's buoy, 8 feet stave hooped on the inside, costs, for coopeage, 40*l.*; if made on the old plan, 18*l.*; a buoy 6 feet in stave, 16*l.*

As there were a large number of old can buoys in store (see Fig. 1), Mr. Poulter has enabled them to float upright when reversed, notwithstanding their deficiency in breadth of base, by attaching to the base an iron span, and they now answer very well; but all new buoys are made on the new principle.



No. (3) is a sketch of Herbert's buoy, made of iron and sufficiently hollow in the base to allow of the chain being attached at about the centre of gravity of the buoy. This buoy is reported to ride very well in exposed situations, tide ways, &c., and to float very upright. There are two or three in the London district; but there is at present no intention of more extensively using them, and Mr. Poulter does not admit their claim to any superior advantages over his buoys, or over

No. (4), Lennox's buoy, also made of iron, and with a flat base.

Some very large buoys, 12 feet long, have been made by Mr. Lennox, but they have been found very inconvenient to transport, owing to their size and shape; the Trinity steamers always tow them to their stations, the other buoys they carry on board.

Objections to Iron Buoys.

An objection to all iron buoys is, that hitherto it has been found impossible to prevent them from rusting, and becoming liable to be mistaken for red buoys, whatever their original colour may have been.

They are also more liable to accidents from collisions, being easily stove.

The wooden buoys are made of wainscot oak, as iron soon absorbs water.

Mr. Lennox claims for the iron buoys that their repairs are, taking one year with another, less expensive than wooden buoys.

Buoy Districts.

England is divided into eight Buoy districts. The Trinity Buoy Wharf supplies all the districts with new buoys, and for this purpose always has a store on hand painted with the first coat of priming; but each district has charge of its own reserve set of buoys.

Buoy Chains.

The wooden buoys are made at Shooter's, the Dock-head, Blackwall. They have $1\frac{1}{2}$ chain, and generally have cables, whose length is equal to twice the depth of water; they ride to square iron sinkers.

Buoy Anchors.

Hollow sinkers are being tried, so as to add the effect of suction to the weight of the sinkers.

*System of Buoyage.*

Mr. Poulter was of opinion that no system of indicating the side of the channel on which a buoy was placed, by any peculiarity in the buoy, as to its form or colour, would be practicable in the Thames, owing to the great number and intricacy of the channels.

LIGHTVESSELS.

The lightvessels remain on their stations seven years, and are then brought in and receive a thorough repair.

Cables.

Their cables are changed every four years, and the old chains ($1\frac{1}{2}$ in.) are converted into chains for the buoys.

Crews.

The crews have no other occupations than their professional duties. Libraries are supplied to each ship.

The crew consists of eleven, of whom four come on shore every month for a month, and are employed in the storehouses at the buoy wharf.

The master and mate are in command month and month about.

Only good seamen are entered by Mr. Poulter.

	£	s.	d.
As lightmen they receive	-	2	15 0 a month.
When advanced to lamp lighters	3	0	6 "
A carpenter receives	-	3	12 0 "
The mate	-	4	0 0 "
The master	-	5	0 0 "

and 10*l.* a year for house rent.

Provisions.

They all find their own provisions, but are allowed to corn their beef at the wharf.

Beer and Spirits.

They are allowed beer but no spirits. No boats are allowed to go alongside the lightvessels, and the men are not allowed to board any passing ship.

Promotion.

The men rise by seniority from the lowest rank to that of master.

Spare Stores.

Spare stores for the lightvessels are always kept in perfect readiness, so that they can be sent off instantly when required.

Oil,—how tested.

The oil is carefully tested, first at the Trinity House, samples being taken from each cask. When the oil reaches the wharf it is again tested, one sample of each cask being preserved in case of future complaints, and another tested by burning. Nine Argand lamps of the same size are lit, eight having been trimmed with last year's oil, and one with the sample. At the end of some hours the lamps, still burning, are carefully inspected by Mr. Poulter, who is in ignorance as to which of the nine lamps is trimmed with the new oil, to see if he can discover any difference. He states that in his experience, owing to

the previous very careful testing at the Trinity House, he has never discovered any difference. The oil used is the best rape seed oil. About 215 tons is required every year for the supply of the Trinity House.

Trinity Buoy Wharf

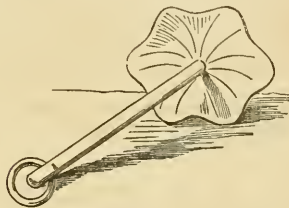
Cables,—how tested.

The $1\frac{1}{2}$ -inch cables for the lightvessels are tested with great care, as follows:—

They are made in Wales, of the best iron, and before being received at the wharf are exposed to a strain of 80 tons. While exposed to this strain they are carefully inspected by Mr. Poulton, to see if there is the slightest symptom of weakness, or permanent alteration in length. The strain is then lessened to 30 tons, and every link is repeatedly struck with heavy sledge hammers. Having stood this test, Mr. Poulter selects a link haphazard in each length of 15 fathoms. This link is cut out and submitted to every possible strain by blows, so as to discover if possible any weakness in the welding or in the constitution of the iron. It is then tallied, registered, and hung up for future reference in case of any accident to the chain of which it formed a part. A new link is sent for from Wales, and the length is stored for use. The chains are very rarely known to have parted. Each vessel has 208 fathoms. She has also a spare anchor and chain.

Anchors.

She rides at her station to a mushroom anchor, and the cable is hove in or veered according to the weather.

*Spare Lightvessel.*

The lightvessels are nine in number in the London district. There is only one spare lightvessel, which is substituted for any vessel under repair. As the repairs are sometimes very extensive, it might of course occur that the spare lightvessel being away, an accident to one of the lightvessels would find the Trinity Board unprepared to replace her, but under such circumstances the spare lightvessel at Yarmouth would be sent for.

Paint.

The lightvessels are painted red. Experience proves that one third Venetian and two thirds red lead are the best proportions for making the red paint.

Balls.

The balls which serve to distinguish lightvessels from others during the day, are made of wood, hollow and open. The straps of wood of which they are composed being painted red. They are in two parts. A collapsing ball made of wood and canvas is always supplied as a substitute in case of accident.



Lighthouse Lantern for Experiments.

A room at the top of the buildings at the buoy wharf is fitted up as the lantern of lighthouse, and a large revolving frame work is placed there. When any new description of light or lamp is to be experimented on, a Committee of the Elder Brethren proceed to a distance of some miles to study and compare

the proposed lights or lamps with some other by which its merits are to be tested, and which is also attached to the frame. At stated and pre-arranged intervals the frame work is moved, and the required comparison instituted.

ALFRED P. RYDER.

CRUIZE OF THE "VIVID."

PERSONAL OBSERVATIONS

MADE BY THE COMMISSIONERS

ON LIGHTS, &c., UNDER THE MANAGEMENT OF THE THREE GENERAL LIGHTHOUSE AUTHORITIES, &c.

ENGLAND. July 4th.—The Commission proceeded to Portsmouth.

Vol. II. 239. July 5th.—The Commissioners met at 9 a.m. at the admiral's office in the dockyard, made some inspections, examined some witnesses, and subsequently embarked on board the "Vivid," and got under weigh at sunset. Admiral Hamilton and Mr. Gladstone previously communicated with the Queen's harbour master and one of the Queen's pilots relative to buoyage and the mariners' questions. They did not appear to be acquainted with the new buoy adopted by the Trinity House, and described in Captain Ryder's Minute as Poulter's buoy; and they admitted that from description it must be preferable to the old-fashioned buoys now used at Portsmouth.

Dr. Gladstone visited the lighthouse at Southsea and made the following report:—

Vol. II. 239. No. 1.—The SOUTH SEA CASTLE lighthouse shows a red light down the channel by which Portsmouth is entered, and a green light over the Swash way. It belongs to the Admiralty. (*See return furnished by the Admiralty.*) Some years ago it was confessedly a very poor light, and could scarcely be distinguished from the gas lamps at Southsea; so it was brightened, and the present dioptric arrangement was adopted. The lenses and prisms are good, but the green glass is very dull, and the red glass streaky in the most important part. As the light is wanted for only a quarter of the circle (or less), and there is no reflector behind the lamp, by far the greatest portion of the light is lost. The lamp also smokes to such an extent that the keeper thinks it necessary to wipe the glass of the lantern several times every night. Till he came (two years ago), there was no means of cleaning the outside panes, although the spray frequently dashes against them; but he had them swung on a pivot so as to bring the outer side within his reach. Sperrin oil is burnt, sometimes so thick that it will scarcely flow, sometimes as thin as wine, and in the winter it occasionally freezes in the pipe of the lamp, so that the keeper is obliged to poke a passage with a hot wire. He believes that before his time it was sometimes allowed to freeze completely. There is but one keeper, who, however, is sometimes relieved in his duties by his wife. He complains that during the two years he has been in the lighthouse he has had but one official visit from any superior.

The members of the Commission who visited the buoy wharf at Portsmouth Dockyard, reported as follows:—

The buoys are made of fir, and the very evident line of flotation, as shown by the barnacles, appeared to indicate that they float very deep. We were informed that they not unfrequently leak. The buoys

were all conical, and fitted to float apex down. Buoys thus fitted cannot watch as well as those of the London district, which float base down. We saw an iron Herbert buoy which was lying unused on the wharf; it was reported to us as having watched well at the Prince's Shoal. No reason for bringing it in was given.

The Commissioners remarked that the light at South Sea was dim as they passed in the "Vivid" on leaving Portsmouth Harbour soon after sunset.

2. THE WARNER.—No. 26.

Vol. II. 122.

The Warner light was just lighted, and began to revolve soon after the vessel was passed.

3. THE NAB, or BEMBRIDGE.—No. 27.

Vol. II. 123.

The Commissioners boarded the "Nab" lightvessel at 9 p.m. and remained on board three quarters of an hour. They were informed that the vessel had been adrift three times during the last 20 years. (The master on shore was afterwards examined at Cowes, and stated that a gong is heard best to leeward, and a bell to windward; but guns are best. Cannot hear a gong to windward in a fog more than a quarter of a mile. Has been three times adrift in 44 years; but chains are much better of late years. Thinks a fine bow would be preferable to bluff bow for riding in a heavy sea. An old lightvessel with a fine bow was the best he ever was in. He has known lightvessels to roll from 35° to 40° broadside to sea. The Trinity Board gave orders for the measurement to be made, but did not supply pendulums.) The crew had just been relieved, but the vessel appeared to be in excellent order. The log was inspected, and the thunderstorm of Saturday and the weather of this day were found to be correctly entered. The agent of the Trinity House visits the vessel once a month. The gong of the Warner, distant three miles, has been heard; the light of the Owers, distant 14 miles, has been seen from this vessel. The reflectors were in very good order generally, but some were observed to be worn in places and scratched in others. The mate in charge was told that the Commission were pleased with the condition of his vessel.

4. THE OWERS LIGHTVESSEL.—No. 24.

Vol. II. 121.

Was sighted at an estimated distance of ten miles, the night being fine, but not peculiarly clear. It is marked in the list of lights as visible at that distance. Boarded the vessel; found the master and the watch (two) on deck. The light in order. The master stated that his father had been on board this

floating light for 58 years; he himself had been on board for 42, during which time the vessel had been adrift only once. Seven witnesses of the first 500 state their knowledge of the fact that the Owers had been adrift. In bad weather the vessel occasionally rides so heavily that the master "cannot lie on the floor of his cabin without holding on to the legs of the table." He has sometimes 195 fathom of cable out. He considers his station to be one of the most exposed; but the Seven Stones is still worse. Reflectors clean, but scratched in places.

The master considers that a vessel built in the shape of a square box with fine ends would ride easier than vessels of the present build, which slope outwards amidships, and suffer when riding across the run of the sea in the tide.

On leaving the Owers the Vivid stood in to sight Littlehampton. (*See the report on the Port of Arundel.*)

The course was then shaped to sight

Mariner's Evidence, No. 7.
COMPARISON OF BEACHY HEAD WITH NINE FOREIGN LIGHTS.

Name.	Nature.	Height.	Visible.	Seen.	Notified by	Compani- bells.	Majorities.
FRANCE, J.							
1. Grisevez	D. 1st, fixed	194	32	35	108	5	0
2. Ally	D. 1st, rev.	305	27	—	1	1	3
3. Pecamp	D. 1st, fixed	436	18	—	—	1	—
4. Le Heve	D. 1st, fixed	397	20	—	1	2	1
5. Barleur	D. 1st, fixed	236	22	—	1	1	1
6. La Hague	D. 1st, fixed	157	18	—	—	1	1
RUSSIA, O.							
7. Dagerort	Fixed	328	22	35	1	1	1
AMERICA, O.							
8. St. Paul's, Gulf of St. Lawrence	?	110	20	30	2	1	—
9. Monte Video	?	186	25	—	1	1	—
Beachy Head	C., 1st, rev.	185	22	32	31	10	8
Total	—	—	—	—	—	18	—

Cruise of the Vivid.

Comparison with foreign lights.

Of 18 comparisons, 10 are for Beachy Head, 8 against.

The result is therefore favourable to the British light, though it is catoptric, and compared with the best dioptric lights in France.

At about 2 a.m., July 5th, the "Vivid" altered course for the Isle of Wight; weather fine, calm, and clear. Of the seven lights seen two only were dim, viz., Southsea and Littlehampton, neither of which are under the Trinity House. The other four appeared to be efficient and fully equal to the account given of them in the list of lights. It was remarked, however, that in certain positions the two lights of the Nab might appear as one, and occasion mistakes.

Wednesday July 6th.—At an early hour the "Vivid," was off Cowes. Captain Ryder and Mr. Graves landed and questioned several persons.

Mr. Spain, Commander of Pilots, can make no suggestion as to improving buoys or lights; would have an indifferent opinion of any pilot who found any fault, "*everything under management of Trinity being so perfect.*" Pilots pay 2*l.* 2*s.* every year to Trinity Board for licence, and are, therefore, quite in power of Trinity Board, who can remove license without appeal.

Mr. Willis, Trinity Agent, over Cowes Beachy Head to Portland. Has 7 buoys and 4 lights floating, and several lighthouses and a cutter tender. Reward to independent parties for bringing in a drifted buoy, 2*l.* 2*s.* Masters of lightvessels have 1*s.* 6*d.* a day to find men in provisions; no complaint was heard. Superannuation of masters when worn out, 55*l.* a year. Active pay 5*l.* a month; 20*l.* in house rent and 1*s.* 6*d.* a day for provisions, not more than sufficient to pay for the requisite provisions.

The Commission proceeded to Southampton (*see report on that place*), and, after coaling, steamed to Bournemouth, anchored, and observed the lights on the Needles and in Poole Harbour (*see separate report on Poole*).

6. NEEDLES.—No. 35.

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This light was visited by the Secretary on the 25th of August. It is of grey granite, almost of the same colour as the chalk rock. It is built on the outermost Needle rock, which has been cut away so as to make a foundation and a platform; cellars and storerooms are also cut out of the rock. The keeper states, that the waves seldom break high about the tower, and there are few days on which a boat cannot approach the landing-place. The illuminating apparatus is dioptric, and the light red. The colour is produced by surrounding the lamp with a screen of red glass, and by placing red shades outside the lens. In parts a cylindrical reflector is placed on the landward side, and there are clear portions to show a white light.

The light has to traverse, 1st, the glass chimney; 2nd, the red glass screen; 3rd, the lens; 4th, a red shade; 5th, the glass of the lantern. The light is said not to be very bright.

5. BEACHY HEAD.—No. 33.

Which should be visible at 22 miles, (catoptric, revolving). Sighted it at 25 miles, not far from Shoreham. The Owers light and the town lights of Brighton and Shoreham being all visible at once. The day beginning to dawn.

On the 25th of August, at about 5 p.m. this light-house was visited by Dr. Gladstone. It is a first-class establishment, in excellent order. There are 30 reflectors, old, but bright, arranged on three faces. They revolve once in six minutes, so that there are intervals of two minutes between the flashes, with 14 seconds of darkness. The keeper (who has been there for 12 years, and was born in the service), complains of insufficient ventilation, though there is a metal chimney over each lamp. Fogs are very common. Stones are sometimes blown up against the lantern, and make holes in the plate glass, some of which were pointed out by the keeper.

The light at Shoreham is often seen distinctly, though 23 miles distant, fixed, and a harbour light under a local authority (*see report on Shoreham*).

The light at Beachy Head is seen plainly from Worthing, 27 miles distant, when the weather is clear and the cliff not enveloped in clouds, but this seems the exception rather than the rule. When very clear, the light at its maximum about equals that of a second magnitude star, but looks red in comparison with any of the fixed stars. It is visible for only about 20 seconds; yet, through the telescope of the refraction goniometer a feebler light could be discovered during the greater part of the revolution, perhaps 1½ min. Red, orange, yellow, and green rays are alone transmitted, the blue and violet being wholly absorbed by the intervening atmosphere. The extreme red ray also could not be detected, so that no light whatever was seen through Cobalt glass. The green rays were very dull; and evidently the portion of the spectrum transmitted most easily, or in greatest quantity was the orange—in all probability the part between Fraunhofer's lines C and D. Similar experiments were performed on the Beachy Head light, as seen from Shoreham, with similar results. The atmosphere exerted a similar absorbent power on the more refrangible rays of the light coming from the gas lamps of Brighton, as seen from Shoreham, five or six miles distant.

From these experiments the following conclusions may be drawn:—

1. A blue light will not be seen far.
2. A green light will be seen farther, but not so far as an orange or red light.
3. An orange light seen through a considerable amount of atmosphere will have the same appearance as a white light then assumes.
4. A red light will be seen nearly as far as a white light, but only provided the glass does not absorb too much of the orange rays.

Of 9 foreign lights compared with Beachy Head, 4 are said to be better, 5 worse.

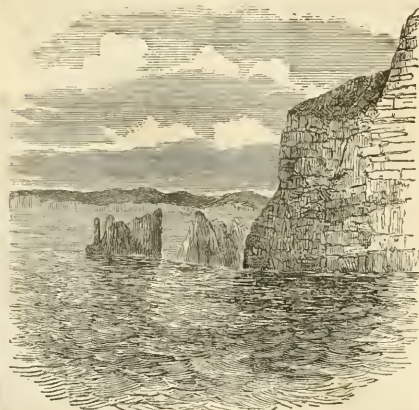
*Cruise of the
Vivid.*

The establishment was in very good order, clean, and neat. There are three keepers, as at other rock stations; two live at Ryde, when on leave, the third at Freshwater.

*Colour of
building.*

Portions of the granite of this building can be rubbed off with the fingers, even more than was found to be the case at the lighthouse on the Skerry More. The colour of the stone of this outbuilding is that selected by duck shooters for their punts. It is a light grey, and it cannot easily be seen, for its colour blends with that of the sea and of the light grey chalk rocks against which it is seen from the sea. A set of observations were therefore made from Black Gang Chine to test the effect of various states of the atmosphere in this particular colour as contrasted with others near it, including the chalk cliffs, a patch of grass almost yellow, but the darkest object near. Is it on the cliff near the old lighthouse, and of about the same size as the Outer Needle rock.

The rock on which the lighthouse stands, and the lighthouse itself, were observed at 9 a.m. every morning for a period of 65 days, and the most distant points visible along the coast were noted at the same time, as well as the general state of the light and atmosphere. In the morning the sun is behind an observer at Black Gang Chine, who is looking towards the lighthouse at the Needles, and consequently the building and cliffs there receive nearly the maximum of light, while the sea reflects the minimum. Still, even under these the most favourable conditions, there were 19 days on which the lighthouse was invisible at 14 miles, though the rocks on which it stands and more distant points were seen. The green patch beside the rocks, and of the same apparent size as the smallest of them, was seen twice when both rocks and lighthouse were invisible. On both occasions the weather was sunny and hazy, and Bournemouth, about 10 miles beyond the lighthouse, and the green patch close to it, were sometimes seen, though the building and the rocks lower down were both invisible. On no occasion was the light-coloured building seen and the darker grass patch invisible; but on seven bright hazy days the light-coloured rocks were seen through the haze when the grass could not be made out. On one occasion Portland Bill, distant 45 miles, was seen, and the lighthouse and the grass patch, at 14 miles, were both invisible, while the rocks could be distinguished. That day is marked sunny and clear, and the chalk rocks shining in the sun probably showed through a partial land fog. On the whole the result of the observations goes to show that lighthouses, if they are intended to be seen during the day, should be coloured with reference to the back ground, and that those buildings which are projected against the sea or sky, or against white rocks, should be coloured DARK. (See Table next column.)



Lighthouse, Outer Rock, Needles Point. Grass Patch, Bournemouth, as seen through telescope.

The observations do but confirm the positive testimony of 657 mariners who, in reply to Question 17, name the colour which they see best on the water at night. Of these, 502 name BLACK or DARK, 29 RED, and of the remaining minority of 82, only 62 say WHITE.

August 1860.—Subsequent observations have fully confirmed these. The lighthouse and the rock on which it stands, seen against the sea, are often invisible when the land at Bournemouth seen over the lighthouse is visible, and the dark patch of grass seen against the sky is also visible. On the evening of the 14th, though Portland, distant 40 miles, and ships on the horizon could be seen with the naked eye, and Bournemouth and the Needles Point were both free from haze,—the rocks and the lighthouse could not be distinguished from the background of sea. It follows that the colour of the back ground should be considered. (*Observations from the 4th August to the 10th of October confirm these.*)

Observations taken at 9 a.m. on 65 days from Black Gang Chine, near the Preventive Station. The Points visible are shown by —; Points invisible by Blanks.

	Brook Point, 8 miles.	Needles, 14 miles.	St. Alban's, 20 miles.	Portland, 45 miles.	General Condition of the Light and Atmosphere.	Lighthouse Grass Patch on Cliff.	Light Grey Outer Rock about the size of the Patch.	Light Grey Building on the Outer Rock seen against the Sea.
1859, August.								
15	—	—	—	—	Sunny Hazy	—	—	—
16	—	—	—	—	Sunny Hazy	—	—	—
17	—	—	—	—	Grey Clear	—	—	—
18	—	—	—	—	Grey Hazy	—	—	—
19	—	—	—	—	Sunny Very clear	—	—	—
20	—	—	—	—	Sunny Hazy	—	—	—
21	—	—	—	—	Grey Hazy	—	—	—
22	—	—	—	—	Sunny Hazy	—	—	—
23	—	—	—	—	Sunny Hazy	—	—	—
24	—	—	—	—	Sunny Hazy	—	—	—
25	—	—	—	—	Grey Clear	—	—	—
26	—	—	—	—	Grey Very hazy	—	—	—
27	—	—	—	—	Sunny Very hazy	—	—	—
28	—	—	—	—	Sunny Clear	—	—	—
29	—	—	—	—	Sunny Clear	—	—	—
30	—	—	—	—	Sunny Clear	—	—	—
31	—	—	—	—	Sunny Clear	—	—	—
Sep. 1	—	—	—	—	Sunny Clear Blow- ing hard	—	—	—
2	—	—	—	—	Grey Hazy	—	—	—
3	—	—	—	—	Grey Clear	—	—	—
4	—	—	—	—	Sunny Hazy	—	—	—
5	—	—	—	—	Grey Clear, Hazy in the distance	—	—	—
6	—	—	—	—	Sunny Hazy	—	—	—
7	—	—	—	—	Grey Hazy	—	—	—
8	—	—	—	—	Sunny Clear	—	—	—
9	—	—	—	—	Grey Clear	—	—	—
10	—	—	—	—	Sunny Foggy	—	—	—
11	—	—	—	—	Sunny Clear	—	—	—
12	—	—	—	—	Sunny Clear	—	—	—
13	—	—	—	—	Sunny Clear	—	—	—
14	—	—	—	—	Sunny Clear	—	—	—
15	—	—	—	—	Sunny Clear	—	—	—
16	—	—	—	—	Sunny Hazy	—	—	—
17	—	—	—	—	Sunny Hazy	—	—	—
18	—	—	—	—	Sunny Clear	—	—	—
19	—	—	—	—	Sunny Rather hazy	—	—	—
20	—	—	—	—	Sunny Rather hazy	—	—	—
21	—	—	—	—	Grey Rainy	—	—	—
22	—	—	—	—	Grey Rainy	—	—	—
23	—	—	—	—	Thick	—	—	—
24	—	—	—	—	Sunny Clear	—	—	—
25	—	—	—	—	Grey Foggy	—	—	—
26	—	—	—	—	Grey Foggy	—	—	—
27	—	—	—	—	Sunny Hazy	—	—	—
28	—	—	—	—	Grey Hazy	—	—	—
29	—	—	—	—	Sunny Hazy	—	—	—
30	—	—	—	—	Rain Thick	—	—	—
Oct 1	—	—	—	—	Rain and fog	—	—	—
2	—	—	—	—	Grey Clear	—	—	—
3	—	—	—	—	Sunny Hazy	—	—	—
4	—	—	—	—	Sunny Hazy	—	—	—
5	—	—	—	—	Sunny Hazy	—	—	—
6	—	—	—	—	Sunny Very hazy	—	—	—
7	—	—	—	—	Grey Very hazy	—	—	—
8	—	—	—	—	Sunny Clear	—	—	—
9	—	—	—	—	Sunny Hazy	—	—	—
10	—	—	—	—	Grey Clear	—	—	—
11	—	—	—	—	Foggy	—	—	—
12	—	—	—	—	Grey Hazy	—	—	—
13	—	—	—	—	Sunny Clearish	—	—	—
14	—	—	—	—	Grey Hazy	—	—	—
15	—	—	—	—	Grey Foggy	—	—	—
16	—	—	—	—	Greyish Clear	—	—	—
17	—	—	—	—	Sunny Clear	—	—	—
18	—	—	—	—	Grey Clearish	—	—	—
65	61	52	29	4	- - - -	42	46	27

The establishment was in very good order, clean, and neat. There are three keepers, as at other rock stations; two live at Ryde, when on leave, the third at Freshwater.

Portions of the granite of this building can be rubbed off with the fingers, even more than was found to be the case at the lighthouse on the Skerry Mhoire. The colour of the stone of this building is that selected by duck shooters for their punts. It is a light grey, and it cannot easily be seen, for its colour blends with that of the sea and of the light grey chalk rocks against which it is seen from the sea. A set of observations were therefore made from Black Gang Chine to test the effect of various states of the atmosphere in this particular colour as contrasted with others near it, including the chalk cliffs, a patch of grass almost yellow, but the darkest object near. Is it on the cliff near the old lighthouse, and of about the same size as the Outer Needle rock.

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Observations taken at 9 a.m. on 65 days from Black Gang Chine, near the Preventive Station. The Points visible are shown by —; Points invisible by Blanks.

1859, August.	Brook Point, 8 miles.	Needles, 14 miles.	St. Alban's, 50 miles.	Portland, 45 miles.	General Condition of the Light and Atmosphere.	Light Green Grass Patch on Needles Cliff.	Light Grey Outer Rock of the Patch.	Building on the Outer Rock seen against the Sea.
15	—	—	—	—	Sunny Hazy	—	—	—
16	—	—	—	—	Sunny Hazy	—	—	—
17	—	—	—	—	Grey Clear	—	—	—
18	—	—	—	—	Grey Hazy	—	—	—
19	—	—	—	—	Sunny Very clear	—	—	—
20	—	—	—	—	Sunny Hazy	—	—	—
21	—	—	—	—	Grey Hazy	—	—	—
22	—	—	—	—	Sunny Hazy	—	—	—
23	—	—	—	—	Sunny Hazy	—	—	—
24	—	—	—	—	Sunny Hazy	—	—	—
25	—	—	—	—	Grey Clear	—	—	—
26	—	—	—	—	Grey Very hazy	—	—	—
27	—	—	—	—	Sunny Very hazy	—	—	—
28	—	—	—	—	Sunny Clear	—	—	—
29	—	—	—	—	Sunny Clear	—	—	—
30	—	—	—	—	Sunny Clear	—	—	—
31	—	—	—	—	Sunny Clear Blow- ing hard	—	—	—
Sep. 1	—	—	—	—	Grey Hazy	—	—	—
2	—	—	—	—	Grey Clear	—	—	—
3	—	—	—	—	Sunny Hazy	—	—	—
4	—	—	—	—	Grey Clear Hazy in the distance	—	—	—
5	—	—	—	—	Sunny Hazy	—	—	—
6	—	—	—	—	Grey Hazy	—	—	—
7	—	—	—	—	Sunny Clear	—	—	—
8	—	—	—	—	Grey Clear	—	—	—
9	—	—	—	—	Grey Clear	—	—	—
10	—	—	—	—	Sunny Foggy	—	—	—
11	—	—	—	—	Sunny Clear	—	—	—
12	—	—	—	—	Sunny Clear	—	—	—
13	—	—	—	—	Sunny Clear	—	—	—
14	—	—	—	—	Sunny Clear	—	—	—
15	—	—	—	—	Sunny Clear	—	—	—
16	—	—	—	—	Sunny Clear	—	—	—
17	—	—	—	—	Sunny Clear	—	—	—
18	—	—	—	—	Sunny Clear	—	—	—
19	—	—	—	—	Sunny Clear	—	—	—
20	—	—	—	—	Cliff	—	—	—
21	—	—	—	—	Cliff	—	—	—
22	—	—	—	—	Cliff	—	—	—
23	—	—	—	—	Cliff	—	—	—
24	—	—	—	—	Cliff	—	—	—
25	—	—	—	—	Cliff	—	—	—
26	—	—	—	—	Cliff	—	—	—
27	—	—	—	—	Cliff	—	—	—
28	—	—	—	—	Cliff	—	—	—
29	—	—	—	—	Cliff	—	—	—
30	—	—	—	—	Cliff	—	—	—
Oct. 1	—	—	—	—	Cliff	—	—	—
2	—	—	—	—	Cliff	—	—	—
3	—	—	—	—	Cliff	—	—	—
4	—	—	—	—	Cliff	—	—	—
5	—	—	—	—	Cliff	—	—	—
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9	—	—	—	—	Cliff	—	—	—
10	—	—	—	—	Cliff	—	—	—
11	—	—	—	—	Cliff	—	—	—
12	—	—	—	—	Cliff	—	—	—
13	—	—	—	—	Cliff	—	—	—
14	—	—	—	—	Cliff	—	—	—
15	—	—	—	—	Cliff	—	—	—
16	—	—	—	—	Cliff	—	—	—
17	—	—	—	—	Cliff	—	—	—
18	—	—	—	—	Cliff	—	—	—
19	—	—	—	—	Cliff	—	—	—
20	—	—	—	—	Cliff	—	—	—
21	—	—	—	—	Cliff	—	—	—
22	—	—	—	—	Cliff	—	—	—
23	—	—	—	—	Cliff	—	—	—
24	—	—	—	—	Cliff	—	—	—
25	—	—	—	—	Cliff	—	—	—
26	—	—	—	—	Cliff	—	—	—
27	—	—	—	—	Cliff	—	—	—
28	—	—	—	—	Cliff	—	—	—
29	—	—	—	—	Cliff	—	—	—
30	—	—	—	—	Cliff	—	—	—
31	—	—	—	—	Cliff	—	—	—
65	61	52	29	—	—	—	—	—

See House on the Point
seen through a telescope



11

e, *Cruise of Vivid.*

Comparis with four lights.

Majorities.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
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Of 13 lights compared with the Start, 8 are said to be better, 5 worse.

Of 17 comparisons, 7 are for the Start, 10 against.

The result is therefore unfavourable to the British light on the whole, though it is said to be better than Grisnez, which is the favourite French light amongst mariners. (*For further observations on the Start and Grisnez, see p. 46, 49, 51.*)

that they were not arranged on any system of or colour.

Observed the lights at the end of

9. PLYMOUTH BREAKWATER.—No. 47.

Vol. II. 8.

The red light, which appears from the list of light-houses to be of the same size and kind as the Eddy-

of the

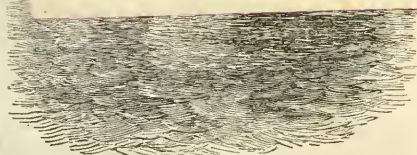
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Hotel, 100 yards.--1-17.



Lighthouse, Outer Rock, Needles Point, Grass Patch, Bournemouth, as seen through telescope.

6									
7									
8									
9									
10									
11		Cliff							
12									
13		Cliff							
14									
15									
16									
17									
18									
19	61	52	29	*	*	*	* 42	46	21

Cruise of the Vivid.

stone, appeared to be very feeble. At a distance of 2 miles and seen at shorter distance it was faint, though it is intended to be seen at 9 miles.

The low light, catoptric, white, was very brilliant while the Vivid was within its horizontal range. The two lights showed almost as one at about two miles, though 15 feet apart.

With the glass the 2 Plymouth lights could be distinguished easily at that distance.

Friday, July 8th.—Anchored at Falmouth at 1:30 a.m. for four hours. The revolving light at

Vol. II. 89. 10. ST. ANTHONY, FALMOUTH.—No. 49.

Colour of building.

showing very well. It was thought that a black panel on the inner side of the lighthouse, where it is seen against the sky, might be an improvement. At 5:30 a.m. steamed westwards. Observed the beacon on the Manacles, at the entrance to the harbour; it is painted black, is lofty, and was very clearly seen.

Passed the Lizard. It was thought worth consideration whether dark marks on these lighthouses would not make them more visible, as the structure is always seen against the sky. The day was bright and clear, and the white buildings were seen at a great distance, but it has been observed that white seen against the sea or sky is not so well seen in dull weather as darker colours. The following table shows the result of the comparison of this light with lights out of the United Kingdom. There is a majority of 1 in its favour in 23 comparisons with important lights. It is said to be better than nine of these, inferior to five; there is, therefore, a majority of four in favour of the Lizard in a comparison with fourteen lights.

Name.	Nature.	Height.	Miles visible.	Miles seen.	Notified by.	Comparisons.	Majority.
Dunkerque	D. 1st., rev.	194	24	46	12	1	0
Grismee	D. 1st., flash	194	22	25	10	1	4
Ushant	D. 1st., flash	272	18	30	12	1	1
Cardouan	D. 1st., rev.	297	27	39	12	1	1
Berlinese	C. 1st., rev.	365	45	49	12	1	1
Cape St. Vincent.	C. 1st., rev.	221	39	1	13	2	1
Gibraltar	D. 1st., fixed	150	15	1	1	1	1
Ceuta	D. 1st., fixed	481	23	28	1	1	1
Camarat	D. 1st., rev.	428	27	1	1	1	1
Genoa	D. 1st., rev.	370	24	1	1	1	1
Alexandria	fixed	180	20	1	3	1	1
St. Paul's, Gulf of St. Lawrence.	—	—	—	—	1	1	1
Havanna	—	—	—	—	1	1	1
LIZARD*	C. fixed	232	20	30	76	12	11

Steamed into Mounin Bay, and landed Dr. Gladstone, whose report on

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11. PENZANCE

Monster Buoy.

will be found under that head. Passed the monster buoy on the Runnel Stone; it was lofty and black, and easily seen. It is a cone moored by the base. The buoy leaned from the tide. This is contrary to Mr. Poulter's statement, that buoys so moored lean towards the tide. Landed without difficulty at

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12. THE LONGSHIPS.—No. 52.

The sea was calm. The house is built on the top of a conical rock opposite to the Land's End. The light is catoptric, 20 reflectors. These were bright and well polished, generally in better condition than those in the lightvessels. This agrees with the statement of Mr. Wilkins, the manufacturer, who said that reflectors in lightships wear out much sooner than those on shore. The house was being painted, but was in good order. The oil was ex-

amined, and found to be clear. The keeper stated that it was good, and a boatman, who was engaged to show the best landing-place, said that the light was "beautiful." There are three keepers always in the house. The head keeper had previously lived at the Eddystone, and preferred that station, though he considers the sea to be as bad there as at the Longships. In heavy weather he states that waves break about the lantern 79 feet above high-water mark. On one occasion the sea lifted the cowl off the top so as to admit a great deal of water. Several lamps were extinguished, and all the men were employed in baling out water till the tide fell.

There is a cavern under the house at the end of a long split in the rock, and when there is a heavy sea the noise produced by the escape of pent-up air from the cavern is so great that the men can hardly sleep. It was stated that one man was so terrified that his hair turned white.

When such sounds are naturally produced by the action of the waves it seems possible to use the same power in the same manner as a fog signal.

Near the Lizard, in a small island, is a cave which at certain states of tide is filled by the waves. At the extreme end of the cavern is a hole about a foot in diameter, which opens towards the land. The rush of air through the opening, as each wave advances from the mouth of the cave, is such as to produce extremely loud sounds, which are heard at great distances. Similar roaring caverns are to be found on the west coasts of Scotland, and it seems easy to imitate this principle on a smaller scale. Though the weather was remarkably fine, and the sea so calm that shoals of grey mullet were resting in the lee of the rock, there was still a sufficient movement in the waves to produce a very considerable hydraulic power, and the sea is very seldom without a ground swell.—See Stevenson's report on the building of the Skerry Shore lighthouse for observations taken to estimate the force of the Atlantic waves, and the sounds produced by them in a small cavern in the rock under that lighthouse.

The Commissioners having inspected the log, which was properly kept, re-embarked, and steamed west for Scilly. Observed the beacon on the Wolf Rock to the eastwards, lofty, colored red, and easily seen.

Took a pilot on board off Scilly, and steamed to

13. THE SCILLY BISHOPS.—No. 54.

Vol. II. 90.

Landed on the rock without difficulty, and inspected the lighthouse. It is built on a rock, which is a little higher and longer than the Eddystone. The building is magnificent, and, perhaps, the most exposed in the world. The head keeper has been in both Eddystones and Longships, and thinks that the sea is worse here, though not much worse. The spray goes over the top of the lighthouse, 110 feet. The vibration appears insignificant as compared with the Eddystone. The light is dioptric, first order, and a beautiful work. A bell, rung by machinery, is fixed near the top. It was sounded when the vessel left, and could scarcely be heard at the distance of a quarter of a mile, though the vessel was stopped on purpose. There was a slight breeze, and the vessel was to windward. This account of a fog signal may be compared with the account given above of the noise produced by the action of the sea in caves.

The house is built of grey granite, painted white. The paint is wearing off, and the colour consequently grey, the worst possible for being seen at sea.

On comparing the tower with the dark-coloured rocks about it the latter showed more distinctly against the water and the sky. On this subject the evidence of mariners as to the colour which they can see best at night, the American and Colonial reports, and the result of the observations made at the Isle of Wight, may be consulted. It is within the knowledge of persons who have shot wild fowl on

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a vessel with a bow like a steamer would ride better
visited. She is 18 years old. Since she has been
fitted with countersunk sheaves to haul chain,



book. The house was very clean, and appeared to
be in good order.

The keeper said that he did not understand lens
lights, but thought reflectors better, because several
lamps might be extinguished without materially in-
terfering with the brilliancy of the light. He said,
however, that the single light of a lens light could be
easily and rapidly replaced, and it is evident that
the care and labour required about 30 different lamps
and a like number of silvered reflectors must bear no

16. GODREVEY.—No. 55.

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Landed, and inspected the lighthouse. It is built on
a rock of considerable size, separated from the main
land. It is large enough to admit of the growth of
vegetables for the lightkeepers, if thought necessary.
Numerous wild plants grow there already. The
spray has occasionally dashed against the lantern in
very heavy weather. There is room for a considera-
ble number of workmen, who, with the contractor
who built the house, were still on the island.

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12. THE LONGSHIPS.—No. 52.

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*Colour of
building.*

the water by day and night, that dark-coloured birds are most easily seen, and that young swans, which are of a grey colour, are the most difficult to distinguish of all wild fowl. It is also well known that smugglers, and coastguardmen, and duck shooters, who wish to conceal themselves on the water, paint their boats, and often dress themselves, in white or grey, which is the colour of the lighthouse on the Scilly Bishops. The agent subsequently stated that the eyes of the men suffered from the glare.

Admiral Hamilton remarked that the keepers showed certain slight indications of a tendency to scurvy. On questioning them, they stated that they often had recourse to the medicine chest. They stated that vegetables would not keep for any length of time.

It is worthy of consideration whether some means should not be provided for supplying the keepers at exposed stations with preserved vegetables, lime juice, or other anti-scorbutics.

The Commissioners were much struck with the general superiority of the building as respects its design, its material, its workmanship and finish, and internal arrangements.

The secretary tested the light with the dark prism at about 1 a.m. next morning, and made it 92 at seven miles. The boatmen said that it was a beautiful "sharp" light. The Trinity House agent stated that the Elder Brethren had steamed so as to compare it with St. Agnes, and that they had seen the latter at a greater distance. St. Agnes is considerably higher.

The "Vivid," on leaving the Bishops ran in to coal at St. Mary's, and the Commissioners landed with the agent of the Trinity House, Captain Tregarthen, and with Mr. Allen, the agent of Mr. Augustus Smith, the lord proprietor of the islands, in a boat rowed by the men of the Seven Stones lightvessel. The master was with them. He was of opinion that a vessel with a bow like a steamer would ride better than one of the present shape. In this he agrees with the other keepers of lightvessels who have expressed an opinion on this subject. He said that his present vessel pitches fearfully. He had once been thrown from the tiller over the companion by a sudden jerk. He did not seem to think that a circular vessel on Herbert's principle would answer, and he stated that one of Herbert's buoys moored in the neighbourhood of the Seven Stones had gone adrift.

The Commissioners rowed about three miles to

14. ST. AGNES, SCILLY.—No. 53.

and inspected that lighthouse at 11 p.m. Mr. Graves and Captain Ryder having mounted the stairs while the chairman and secretary were inspecting certain books below, found the door of the lightroom locked, and the keeper absent. He came almost immediately, and stated why he had left the house, and that he was not obliged to remain always in the lantern.

He stated that during his experience of 21 years the chain of the revolving apparatus had only once broken, and was then replaced in a few minutes, during which the frame was kept moving by hand.

There are 30 lamps and reflectors set in three tiers, and revolving on a frame with three faces. The reflectors were in good order, though some were 50 years old. The light seen from a distance was remarkably bright. The log was inspected, and the names of the Commissioners entered in the visitor's book. The house was very clean, and appeared to be in good order.

The keeper said that he did not understand lens lights, but thought reflectors better, because several lamps might be extinguished without materially interfering with the brilliancy of the light. He said, however, that the single light of a lens light could be easily and rapidly replaced, and it is evident that the care and labour required about 30 different lamps and a like number of silvered reflectors must bear no

comparison to the labour of cleaning and arranging the one lamp and dusting a glass lens. *Cruiz of the Vivid.*

The Commissioners descended from the lighthouse to the beach in the dark, and returned on board at about 1 a.m.

The following is the result of the comparison of this light with lights not in the United Kingdom, abstracted from Mariners' Evidence, and shows a majority in favour of St. Agnes:—

Names.	Nature.	Height.	Miles visible.	Miles seen.	Notified by	Comparisons.	Majority.	Comparison with foreign lights.
1. Grisez	D. 1st., flash	194	22	35	108	* O *	1 — 1	
2. Berlingas	C. 1st., rev.	365	25	—	12	1 — 1	1 — 1	
St. Agnes*	C. rev.	183	16	—	3	2 — 2	2 — 2	
							4	3

July 9th, at 10½ a.m. Steamed for the

15. SEVEN STONES.—No. 29.

Boarded the vessel without difficulty. Some of the men on shore having stated that the quantity of provisions was insufficient for "hearty" men, and the quality "indifferent," the Commissioners inspected the provisions. They found them of good quality. Bread said to be hardly sufficient for hearty men. The men, 11, were clean and neatly dressed; the vessel very clean, and newly painted. The reflectors the best polished that have been seen hitherto, not a scratch to be seen. The shape of the vessel appears slightly sharper forward than that of the others visited. She is 18 years old. Since she has been fitted with countersunk shackles to her chain she has never been adrift. The vessel is provided with guns and a gong. They sound the latter during fogs, and fire the former when they see vessels approaching the Stones. Foreign vessels seldom appear to notice the signals. The mate has only seen one wreck on the Stones. Then they saved one man with their boat, a common one. They have two boats, but no lifeboat. The vessel rides in 42 fathoms, and has occasionally nearly 300 fathoms of 1½ inch chain out.

Though this is the most exposed vessel on the coast the master considers that from the length of the sea she rides easier than vessels moored in a shorter sea. As he expressed it "she is always ready for it," but still her decks are occasionally swept by the sea, and when it strikes her forward "it is like a four-pounder going off."

This statement may be compared with that of the master of the Owers lightvessel (*ante*) and that of the master of the lightvessel in the Humber (see Hull), both of whom seem to consider a shorter sea more dangerous.

On the 14th, at Liverpool, one of Mr. MacIvor's captains stated, with reference to this light, that it was the worst he knew. He passes it constantly, but not very near. It certainly was in very good order, the small lamps and reflectors used on board lightvessels, even in the best condition, cannot be powerful.

Steamed for

16. GODREVEY.—No. 55.

Landed, and inspected the lighthouse. It is built on a rock of considerable size, separated from the main land. It is large enough to admit of the growth of vegetables for the lightkeepers, if thought necessary. Numerous wild plants grow there already. The spray has occasionally dashed against the lantern in very heavy weather. There is room for a considerable number of workmen, who, with the contractor who built the house, were still on the island.

Cruise of the Vivid.

Internal observation, direction of beam.

The light is dioptric, 1st order, 120 feet above the sea. On looking from near the point where the light is placed the horizon was seen nearly in the centre of the main bands of the lens, and in all the prisms. The light appears therefore to be correctly placed with reference to the lens, but it is worth consideration whether a reflector might not be introduced on the landward side, so as to send those rays to seaward which now serve only to light up the cliff and the narrow channel inside.

It was remarked that the outer galleries were of iron, and already showed signs of corrosion. Some of the small internal fittings, door handles, window fastenings, &c., were scarcely equal to a first-class building. This lighthouse is much visited. Nearly 1000 persons landed on the island on Whit Monday, but at this time of year it has been inaccessible for five weeks together.

Godrevy correspondence. Abstract.

The building of this new establishment has been the subject of correspondence amongst the lighthouse authorities. The Commissioners had procured copies, and the following is a short account of the contents of the parliamentary paper ordered to be printed, 8th February 1855, which contains the correspondence.

The first letter is dated 23d January 1855, and is a formal request from the Trinity House to the Board of Trade for sanction to the expense necessary for constructing a lighthouse in a locality to be selected by a committee of Elder Brethren.

It sends enclosures, eight in number, which are petitions addressed to the Trinity House by persons interested, pilots, seamen, merchants, shipowners, fishermen, &c., &c., all praying for a lighthouse to indicate the position of the dangerous reef of rock called "The Stones," near St. Ives, in Cornwall.

On the 13th of July 1855, the Board of Trade were informed that the deputy master and a committee of the Elder Brethren who had examined the locality were unanimously of opinion that a lighthouse might be advantageously erected on Godrevy Island, and that site was recommended by the Trinity House.

The report enclosed gives the reasons, and points to the outer danger as the best site, though to build a lighthouse on it would be difficult and expensive.

On the 12th of September 1855. It is suggested from the Board of Trade that the most northern stone might be selected as the site of a lighthouse, and failing that St. Ives Head on shore is mentioned.

The letter is accompanied by a map, and a letter from Commander George Williams, surveying officer on the station.

On the 19th of September. The Elder Brethren point out that they fully concur in the opinion that the outer danger is the more eligible site, and that it was the question of expense alone which prevented them from recommending that position for their Lordships' sanction.

On the 19th of October. The reports of the engineers are transmitted from the Trinity House to the Board of Trade.

On the 13th of September. Reports of two committees of Elder Brethren are transmitted, together with an urgent recommendation of the site proposed, namely, the Stones. Failing that, the Committee again recommend Godrevy Island.

On the 9th of October 1856. The Board of Trade request that before sanctioning the building of the new light, Mr. Walker, engineer to the Trinity House, may be requested to state what would be the difference in expense occasioned by the substitution of the inner for the outer stone.

On the 27th the Elder Brethren transmit a report from their engineer, and say that "the saving which may possibly be effected by the substitution of the inner for the outer site is so inconsiderable in amount as to prevent them from recommending its adoption."

On the 14th November 1856. The Board of Trade, in a communication addressed to the War Department, inquire whether it would be possible to have the

position of a newly built fort on St. Ives Head changed, so as to admit of the building of a lighthouse there, and they intimate that the building and maintenance of a lighthouse on the outer stones would be attended with too great an expense.

On the 6th of November. The Trinity House transmit memorials praying for the light, which are acknowledged on the 13th of November, with a statement that the matter is under consideration, and a reply expected relative to a site on Battery Point.

On the 15th. The reply of the War Office was sent refusing the proposed site, but offering another on that of the magazine, on condition that a magazine for 50 barrels of gunpowder should be erected adjoining the battery, upon a plan to be furnished by the War Department. Failing the site proposed, another, having reference to the line of fire of the guns, is suggested.

On the 28th of November. Their Lordships decline the site proposed by the War Office, as they do not think that the tower could be placed as proposed without being liable to injury when the guns are fired. And,

On the 29th November. The Trinity House are informed that the battery site being unattainable, or dangerous from the situation of the battery, and the outer stones, though the most eligible, too expensive, their Lordships think that the lighthouse must be built on Godrevy Island, but, as strict economy should be consulted, further plans are asked for, and it is suggested that the establishment should not be treated as a rock light.

On the 4th of February 1857. The Trinity House transmit a memorial praying for the placing of a temporary floating light, which request, on the 12th February, is refused.

On the 4th March 1857. The Trinity House forward a memorial praying for the erection of the light on the outer stone, and for a temporary floating light in the meantime.

In transmitting the memorial the Elder Brethren do not press their view, but they state that "should their Lordships see fit to comply with the prayer of the memorialists, such a course would meet with the cordial concurrence of the Board."

On the 9th of March. The Trinity House are informed that as the question has been settled, and the preparations for the erection of the lighthouse now in progress, my Lords consider that the subject should not be reopened.

On the 12th of April 1857. Their Lordships approve of the plan for a stone lighthouse, and consent that the establishment may be treated as a rock station, but they recommend that tenders for the construction of the tower be invited in the local newspapers.

The correspondence concludes on the 18th November 1857, with a letter from the Board of Trade, addressed to certain memorialists, in which it is stated "that it was after very full consideration decided to erect the lighthouse on Godrevy Island, and the contract having been entered into for its erection at that place, their Lordships cannot now entertain the application."

The lighthouse, which had been threatened in embryo with so many dangers from fire and water, was ultimately built where it was originally proposed to build it, on Godrevy Island, between Battery Point on shore and the outer stone, which is covered at high water, where it is inaccessible to men in bad weather, and safe from waves.

The Lighthouse Commission having previously directed their attention to this correspondence, examined the locality, and came to the conclusion that the outer stone was the best site for the lighthouse. Having visited the Eddystone and the Scilly Bishops, the possibility of building on the outer danger was proved, and it was equally manifest that the danger would be best indicated by placing a light upon it.

Remarks on correspondence.

On leaving Godrevey steamed to

17. TREVOSE HEAD.—No. 56-57.

The lighthouses are built on a lofty promontory. There are two, marked D. 1st order, the highest 204 feet above the sea. It is not compared with foreign lights by mariners in their evidence, and is not mentioned by them, though it is considered to be one of the finest lights in the kingdom. Its position out of the track of vessels running for the great ports may perhaps account for this, but a great number of vessels were seen in the neighbourhood. Landing below the lighthouse appeared to be difficult, if it were possible, and it would have cost too much time to land in the bay and walk round. After waiting for about half an hour, looking for a landing place, steamed for

18. LUNDY ISLAND.—No. 58-59.

Saw the light soon after sunset, distant about 15 miles; it is intended to be seen at 30; and one of the mariners who has replied to the queries circulated, has seen it at 45, the greatest distance at which any light, at home or abroad, has been seen by any one of 814 witnesses.

The upper light is revolving, D. 1st order, showing a flash every two minutes. The lower light is catoptric, and has nine large reflectors. It is only visible between NNW. and WSW. The highest light is 540 feet above the sea, and some of the witnesses complain that it is often obscured by fog collecting about the summit of the island. The keeper, subsequently, stated that "whenever there was any fog about it came his line."

Anchored at the back of the island, got a pilot to show the way, and landed. The chairman, Captain Ryder, and the secretary walked up to the lighthouse in the dark. The island is frequented by a vast number of birds, which build in the rocks. They were heard on all sides, on the water, in the air, and on the land, screaming and apparently fighting with each other. The path upwards is steep, but it was too dark to see much of anything. Near the top is a house, inhabited by a gentleman's family in summer. On arriving at the lighthouse it was remarked that the whitewashed walls of the dwelling house could hardly be distinguished from the sky. The under keeper was found at his post. The head keeper, who was off watch, was called, and accompanied the Commission over the establishment. It appeared to be in first-rate order. The lens was made by Chance, Brothers, of Birmingham. The metal fittings were painted; those at Godrevey were bright. This observation relates to the difficulty of cleaning bright metal, and the danger of injuring the angles of the prisms during the operation. There is also the danger of injuring the polish of the lens with the materials used for polishing brass, and the extra care and labour does not appear to give any corresponding advantage.

The reflectors were well polished, and every part of the establishment a model of cleanliness. The keeper stated that the lens light was not half the trouble of a reflecting light of equal power.

July 10th. On leaving the island at 1 a.m., immediately after the return of the Commission from the lighthouse, steamed round to compare the upper dioptric with the lower catoptric light. On comparing them through the dark prism from a distance of about two miles no difference could be discovered. When the upper light was at the brightest it appeared to be exactly the same as the lower. The light being 540 feet above the observer, and the lenses in all cases being made to throw a beam at right angles to the axis round which they revolve, it is probable that the upper light shows to greater advantage at a greater distance nearer to the sea horizon, which was calculated to be distant 25 miles from the light.

That these lenses are so made and set was sufficiently manifest from the place where the "Vivid"

lay at anchor. As the lenses revolved the beam of the light collected by each became clearly visible over head, lighting up a path in the haze, which, though sufficient to make the beam visible, did not much obscure the light. These beams were clearly seen like the spokes of a gigantic wheel, diverging as they receded from the source of light, and radiating from it as a centre.

The dark prism was previously tested on several stars, and as various observations of the same star produced the same result, the instrument appeared to be well fitted for comparing the intensity of artificial lights. It consists of a wedge of dark glass cemented to one of clear glass, so as to produce a solid parallelogram. By sliding a screen from end to end the light is seen through various thicknesses of darkened glass, and when it becomes invisible the result is read off on a scale. The standard is the power of the observer's eye, and varies in different persons and at different times with the same person; but for comparing two lights side by side it must show which is the brighter.

The comparison then goes to show that nine reflectors in very excellent condition, set so as to throw the light of nine lamps in one direction, only produced the same effect as one of the 8 beams from the revolving light produced from one large lamp.

The fixed light seen between the flashes was very feeble in comparison with them. It is produced by a number of fixed prisms placed below the revolving portion of the lens. The revolving portion somewhat resembles a large beehive with 13 sides. It was observed that the upper part of this was attached to the lower or central portion, so that the angle and sides do not correspond, and it was surmised that this was purposely done so as to lengthen the duration of the flash by increasing the lateral divergence of the beams. This arrangement must diminish the power of the flash. It was also remarked that the light thrown by the lower prisms on the interior fittings of the lantern was crossed by dark spaces corresponding to the number of the prisms, as if they were not set for the same distant point. The keeper said that the light would appear as one at a distance, but it is probable that these prisms are purposely made to throw diverging beams downwards on the sea near the island.

The following is the result of the comparison of the light at Lundy Island with lights not in the United Kingdom, taken from Mariners' Evidence:—

Name.	Nature.	Height.	Miles visible.	Miles seen.	Noticed by	Comparisons.	Majority.
1. Grinsez	D. 1st., flash	194	22	35	168	5	0
2. Isle de Bas	D. 1st., rev.	225	24	27	2	1	1
3. Belle Isle	D. 1st., rev.	278	27	1	1	1	1
4. Berlinese	C. 1st., rev.	565	25	1	1	1	1
5. Roca Lisbon	C. 2nd., rev.	585	21	4	1	1	1
6. Cape St. Vincent.	C. 1st., rev.	221	30	13	1	1	1
7. Genoa	D. ? Rev.	370	24	—	8	1	1
8. Pelorus	D. 4th., flash	72	13	1	1	1	1
9. Cape Ottaway	-	—	—	—	1	1	1
10. Highlands, New York.	-	—	—	—	1	1	1
11. False Point, Bengal.	-	—	—	—	1	—	1
Lundy*	D. 1st., rev.	540	30	45	55	15	5

Majority in favour of Lundy, 10 on 20 comparisons, and as compared with 11 other lights it is pronounced superior to all, except one. This light has been seen at 45 miles by one witness, at 35 by two, at 33 by one, and at 30 by 5. It ranks first amongst all the lights mentioned, either at home or abroad.

Anchored off Pembroke Dockyard, and in the evening left word for the captains of several Irish steamers that the Commission would be glad to see them in the morning if they had any statements to make relative to lights, buoys, or beacons.

Monday, July 11th. Coaling till 10 a.m. As the

Cruise of the Vivid.

masters of the Irish steamers did not appear it is to be presumed that they had no complaints to make.

Admiral Hamilton visited Mr. Hammond, a retired commander of one of the Government Milford Mail Packets.

He stated that two small lightvessels were formerly maintained off the Shear, and were maintained by the Government. These have been discontinued since the Post Office Service terminated, but Mr. H. thinks they would be necessary for working the harbour properly at night.

Water supply.

The "Vivid" was delayed for some time in consequence of the total want of provision at Pembroke Dockyard for watering ships of any kind. Steamed out of Milford Haven and landed at

on the Scilly Bishops by saying that it was a first *Colour of painting, performed by the builder. He thinks white building.* the best colour for lighthouses as the most conspicuous when the sun shines. On this point the evidence of those who look at the object is of more value, and grey light should be considered rather than bright sunshine.

The keeper misses vegetables. The medicine chest was inspected and no bottles had been used, but salts and castor oil. The head keeper appeared healthy.

Descended the rock by a stair cut in it, and remarked the crane which is used in bad weather for landing stores. Re-embarked easily, and steamed 20 miles to

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19. THE SOUTH BISHOP ROCK.—No. 75.

The lighthouse stands on a rock of some size, and is marked D. 1st order, 144 feet above the sea. The painters were at work. The lens is a part only of the old lens from Lundy, and was placed a year ago instead of a reflecting light. There is only the central band of lenses with eight faces; there are no prisms above or below, and the greater part of the light is thus allowed to escape.

The lens is composed of many small pieces cemented together; the joints were very evident as compared with lenses previously seen, and similar lenses were afterwards seen in the museum of the French lighthouse authorities, and in use in other British lighthouses. The illuminating apparatus, consisting of a small portion of the whole, and that of an inferior description, cannot properly be called "first order" dioptric.

The keeper stated that people on shore and the light-keeper at the Smalls thought that the light was brighter and far stronger since the change. This evidence is again strongly in favour of dioptric lights. The keeper is 64, and has been employed for upwards of 38 years about reflecting lights. He considers it very troublesome work to clean the glasses with brushes and spirits of wine; but admits that there is more labour in polishing eight reflectors and cleaning an equal number of lamps which were formerly used at this station. His evidence may be contrasted with that of the head keeper at Lundy Island, a younger man, who has charge of two lighthouses on different principles.

Spray occasionally strikes the lantern, and it has broken the lower windows of the dwelling-house. There is a patch of grass in front of the door; rain water is collected from the roof. In order to avoid the salt the keeper turns the spout from the reservoir for some time after the rain begins, so as to allow the roof to be well washed. When it is sufficiently washed he turns the spout into the cistern. The water was tasted and found to be good. This simple contrivance was thought worthy of notice, as it might escape persons not forced to think of such expedients.

Water supply.

The keeper has often seen vessels very near the rock when fogs cleared up. He has a gong, but no bell and no gun; there is plenty of room for the latter.

He is provided with five red glasses in a box, through which he tests the light of the Smalls three times every night; and his light is similarly tested by the keeper at the Smalls, who also tests St Ann's in a similar manner.

The whole establishment was in very good order, well and neatly kept.

The painter stated that the paint was in a very bad state when he came. He said that the horizontal water spouts, being square and made of iron, rust, overflow, and damage the paint. He suggested round gutters of a different metal. He thought that work done by contract for the Trinity House was very inferior to work done by the paid servants of the House. He accounted for the bad state of the paint

Comparison of dioptric with catoptric apparatus.

Paint.

20. THE SMALLS.—No. 74.

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This is an old wooden lighthouse, built 1778, on *Income, 1852, 22,759l. 2s. 7* piles, at one end of a low rock 20 miles from land. A

new stone lighthouse, partly built, stands on the other end of the same rock, and shows the improvement that has taken place in lighthouse architecture since that time. The rock is not so high as that on which the Scilly Bishops is built; it is about the same height as the Eddystone but larger. There is room to walk about. It is above high-water mark, but the sea breaks all about the lantern of the old light and over the new building whenever there is heavy weather. Green seas pass up to a point about 32 feet above the level of the rock. A foreign ship once struck at the end of the rock in broad daylight. The crew, 12 men, leaped on shore; the vessel drifted about three miles and sank. On being asked how they had fed so many men, the keepers replied, that they always had six months' provisions when they came off. The head-keeper has been 18 years on this station, and prefers it to any other; he has refused to change. He is a native of Wales; is married, and has a considerable farm on shore. The under-keeper is a native of Ealing, a watchmaker by trade, and "would rather be anywhere on shore at half the money." He said, "This is rusting a fellow's life away." A more extraordinary dwelling cannot well be imagined, or a greater contrast to a watchmaker's life at Ealing. The head-keeper said that he had caught woodcocks in September, as also larks, starlings, and blackbirds. Five years ago he caught a *Birds.* partridge on the night of the first of September. He thought that probably the shooting had driven him to sea. "He was very fat indeed." He also caught a *Seals.* young seal by descending from his perch in the lighthouse and placing a bag in front of him as he slept. "He poked him up behind with a stick, and in he went."

Both these were intelligent men, and said that the Bishop's light was much improved since the change to the dioptric system; a reference to the account of the apparatus will best show what that change is, and what might be anticipated from a still further improvement.

Twelve observations made with the darkened glass were compared with 12 made at the Bishop's on this light. These gave 44 Smalls, 48 Bishop.

The Smalls has 27 large reflectors, which were beautifully kept. The Bishop a small portion of an indifferently dioptric apparatus and one large lamp.

The old lighthouse was ascended by a rope ladder. *Description of building.*

The piles, though they have stood for so many years, look very insecure; they are set upright in the rock and have a few props on one side to resist the greatest force of the waves. The upper part consists of a sort of platform, on which provisions and stores are placed, which are not easily damaged by water; above that is a wooden barrack, an octagon cabin in which the workmen employed about the new building sleep in berths like those of a ship, and they sleep on the floor if there are too many; above that is the light-keeper's sleeping room and kitchen in one which is entered by a trapdoor; above that is the lantern. In heavy weather, when the sea is dashing

Description of building.



On 11th July 1879. - Old light vessel - 177 ft. - 20 miles from Wick coast
 40 miles from Newcastle.

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 Waterford.

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This is said to be the best Irish lightvessel. The
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 worst at the Kish. "It is short." "Here, though much

I.

vessel moved. July 12, passed

24. THE TUSKAR—No. 134.

at about 2 a.m. Two white lights, and a red; re-
 volving, intermittent, burning satisfactorily. Weather

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Comparison of
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Paint.

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 gutters of a different metal. He thought that work
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 is the light-keeper's sleeping room and kitchen in one
 which is entered by a trapdoor; above that is the
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about the lower room, workmen and all congregate in the upper room. The whole structure trembles and sways about, and it has been known to lean nine inches from the perpendicular. The whole was as neat as was possible under such circumstances, and the lantern, especially, and all belonging to it was in excellent order.

A coppery reflection which had been observed on the silver of the reflectors in other lighthouses, both by day and night, was here found to proceed from the bright copper backs of the reflectors shining through the hole for the chimney.

On descending from this old lighthouse the party ascended the new one by the help of a chain, and the courses of the lower masonry, which form narrow steps. A ladder will be fixed when the building is completed. The lowest room is now nearly ready, and the lower part of the building is filled with fresh water and acts as a well, which proves the excellence of the workmanship.

The stones are all prepared and carefully fitted on shore,—the lighthouse is, in fact, actually built there. Each stone has a square hollow on each edge and a square hole in the centre; when placed, a wedge of slate, called a “joggle,” fits into the square opening formed by joining the two upper stones. The joint is placed exactly over the centre of the stone below, into which the joggle is wedged before the two upper stones are placed. The result is that each set of three stones is fastened together by a fourth, which acts as a pin to keep the tiers from sliding on each other. The base of the structure is solid. Two iron cranes slide up an iron pillar in the centre of the building, and are fixed by pins at the required position as the work advances. The two are used together so as to obviate any unequal strain.

This excellent workmanship, and its progress beside the old lighthouse, was striking and instructive. The foreman had been engaged in building the Scilly Bishops, and said that this station was less exposed though not much. No stone has been moved from its place since the work began, but, as a proof of the force of the sea, an iron bar about two inches thick and three feet long was shown; it was fixed in the rock and had been bent like a wire. The tools of the workmen, coals, and such like, are kept in places quarried in the rock and covered with wooden doors which slope from the offing; these are often 30 feet under water.

This inspection of a lighthouse in construction on such a spot gives a fair idea of the difficulties overcome in constructing such an edifice as the Scilly Bishops. The foreman caught and presented to the Commission a fine rock fish; he added that no one ever fished there for amusement for the fish were too valuable and might be scared away.

On leaving the Smalls steamed for the Irish coast, and boarded the

exposed, the sea is long, and less difficult to ride in.” *Cruise of the Vivid.*

Here, then, the statement of the master agrees with the statements of those on board other lightvessels. The Longships and the Coningbeg lightships, though the most exposed in the kingdom, seem to ride easier than vessels in much more sheltered positions, and the master of the floating light in the Humber complained of the sea in the river as the worst he had ever encountered.

The men were mustered and inspected. The master is Scotch, the rest Irish. They were all fine men, well dressed, and clean. Inspected the medicine chest; salts and castor oil only had been used. Inspected the log, which was regularly kept, but has no printed heading as elsewhere. Inspected the oil; it looked thick, but the master said “it burns well.”

There is no local agent, but the superintendent, Captain Roberts, visits once a month in a store tender, which brings off supplies on the 1st, 10th, and 20th of every month. The corporation visit once a year, “weather permitting.”

The men have 2*l.* 1*l.*s. a month, 1*s.* 3*d.* a day to find themselves; they complain that the allowance for food is insufficient, and only allows of meat twice a week. No beer or spirits are allowed on board. The master has 7*l.* a month, and the same allowance as the men; he has been 26 years in the service, and has never had occasion to dismiss a man. He has been in various lightships.

He showed a contrivance for making the trimming of lamps, when hoisted, safer. A man was killed last year by falling off the Jacob’s ladder, while trimming the lamps in a heavy sea.

Inspected the reflectors. They were not very bright, and, in common with most others seen on board of lightships, they were scratched. The vessel appeared to be in first-rate order, and has not been adrift within the last two years.

At 9 p.m. left the vessel, and observed the lights which were then hoisted. They did not appear to be very bright.

Steamed into Waterford Harbour, to take in a pilot at Dunmore, failed in obtaining one, so inspected the Harbour light.

22. DUNMORE.

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Waterford.

There are three large reflectors: two covered with red glass, showing to seaward; one clear, showing up the river. These were in very tolerable order, but not so brightly polished as those in the first-class lighthouses which have been visited. The keeper spoke favourably of the oil, and showed a glass of it. His log, or oil account, was made up to the end of May in form, and kept in a rough book up to the present time. He stated that he had written for a new book on the 30th of May, and that he had received no answer, and that Mr. Halpin, the superintendent, visited him about once a month.

Embarked about 10½ p.m., and observed the Harbour lights at Waterford and Duncannon burning clear. Steamed past

23. THE HOOK.—No. 135.

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Did not land, as the Commissioners wished to see Tuskar alight. The Hook light was burning well, but could not be seen at Coningbeg, ten miles off.

The Coningbeg light was passed at midnight, and was also burning well, but could not be seen at any great distance. There was some haze in the atmosphere, but the night was fine. There was a little sea on, and the light appeared to “wink” as the vessel moved. July 12, passed

24. THE TUSKAR.—No. 134.

Vol. II. 230.

at about 2 a.m. Two white lights, and a red; revolving, intermittent, burning satisfactorily. Weather

21. CONINGBEG LIGHTSHIP.—No. 37.

LAND.
Vol. II. 265.
off Saltees Rocks.

Boarded the vessel, which is coloured black with a white stripe to distinguish her from the floating lights on the English coast, which are red.

She had three masts with black balls and two lights; she appeared to ride very easily, and the master said she rode “beautifully.” She is moored in 32 fathoms, and rides by 170 fathoms of chain. One spare chain is 1½ inches, the other 1½. The chain is hove in quite short once a month, and runs on a roller low down in the house outside.

There are 200 fathoms in each chain, made in lengths of 20 fathoms, with a swivel at each 10, and with a mushroom anchor. 170 fathoms are generally out, the shackles are countersunk. There is a fog gong on board, but no gun; the gong is sounded every ten minutes in fogs.

This is said to be the best Irish lightvessel. The Kish to be the oldest and the worst. The sea is worst at the Kish. “It is short.” “Here, though much

Cruze of the Vivid. rather hazy. Having no pilot, and heavy swell on, did not land. At 3 a.m. boarded the

Vol. II. 265. 25. MONEY-WEIGHTS, or BLACKWATER.—No. 36.

The vessel is so named on the Admiralty charts; in the Admiralty list of lights she is called the Blackwater, and that name is painted on her sides. This caused some hesitation, and might cause some confusion.

The vessel has three masts, with two lights, one revolving. The lights were lowered at sunrise, as the vessel was boarded.

The reflectors were bright and well polished, but a little scratched; they were fully as well kept as any yet seen, except those at the Seven Stones, which were peculiarly good.

This vessel came on the station in 1857. The master is an Englishman; he stated that the master of the next vessel to the northward was a Welshman, and the next an Irishman. The crew are Irish.

There is no service on board on Sundays, the crew being of various persuasions.

The vessel was built at Cork. The machine for the revolving light was contracted for by Chance of Birmingham, and is supposed to have been made by Milne of Edinburgh. The master says the vessel rides very well; he has a fog gong which is sounded, a bell which is not used in fogs, but no gun; he has rockets and blue lights. No meteorological instruments are kept on board. In summer the vessel is moored by 120 fathoms of chain, in winter 200. The only books kept are the log and oil books; these were regularly kept, and entered up to Monday. There are no observations taken of neighbouring lights. The Tuskar is only seen occasionally, before or after rains (distant 18 miles). The allowance of 1s. 3d. for food is considered insufficient. There are no fire buckets. The vessel was roomy and very clean; the oil room was a model of cleanliness. The master said "he had never taken in a sea." That the vessel, in his opinion, was properly placed. He could not account for the wreck of the Pomona, close to this station, but by a mistake in the reckoning. The wreck was seen from the deck. There was a library on board, and the master had a turning lathe, which he had taught himself to use. He was bred to the sea. Steamed in to

There is neither bell, gong, nor gun. The clock was wrong, but the keeper made up for that "by taking the time from the passage of a railway train along shore at a distance of about three miles." There was a barometer and a register; but the instrument was old, and of bad quality. The fog settles more about the upper light, and still more about the old tower, which is still higher. The spray strikes the windows of the lanterns. There is no medicine chest. There is no lightning conductor.

The keeper has been 35 years in the service. The under-keeper died some time ago, and the upper keeper's son, aged 17, is assistant, at 40*l.* in the meantime. The corporation have not visited for two years. The inspector was there "two years ago last June." There is no visitors' book, and very few people visit the place.

Embarked and stood for

28. THE KISH.—No. 34.

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Boarded that vessel at half past 12. She is a three master, with one ball and three lights of 8 reflectors each, 140 tons burden. There are six spare reflectors; they were in good order, but, as is usual in vessels, scratched. The lamp lighter, the oldest man in the service, said that these reflectors, made by Wilkins, were very badly silvered. He said that it was "exceeding difficult to keep reflectors in order at sea." "The ironwork of the lamps is also peculiarly difficult to keep clean." Called his attention to the scratches. He could only account for them by the sea water. The oil room was a model of cleanliness. The mate in charge has been 15 years in the service, and four in this vessel. The new vessel has never been adrift. The old vessels, which were shorter, and not so fine in the bows, were often adrift, oftener here than on any other station. The vessel rides in nine fathoms, with 140 fathoms of 1½-inch chain. The mate stated that on heaving in the cable after the heaviest gale, the 90 fathoms next the anchor have never been raised from the bottom. This is ascertained by finding barnacles on the upper part and none on the lower part of the chain. This argument must be taken for what it is worth. There is a gong, as usual, and a gun, also rockets and blue lights. There is a medicine chest. The commonest complaint "dysentery." No meteorological instruments. Gales are foretold by observing a heavy sea, which comes in sometimes 12 hours before the gale. There are two boats, which have never been used to pick up wrecked men. A wrecked crew did come on board in their own boat some time ago. The crew, seven, were mustered, and were fine looking men. They consider their victualling allowance, 1s. 3d., insufficient. They are allowed neither spirits nor beer on board. They think the new vessels a great improvement on the old. One of the old vessels was subsequently seen laid up at the wharf at Dublin, and was evidently an inferior craft in every way.

Landed at Kingston at 2.30, and went by rail to Dublin. Called at the office of the Port of Dublin Corporation, and saw the whole staff of the office. They exhibited portions of the work entailed on them by the questions of the Commissioners. The calculations required to extract the financial statements were most intricate and voluminous, principally in consequence of the present system of charging so many one-sixteenths of a penny for every light passed.

The questions asked, viz. "What is the income derived from each light?" appears a simple one, but to answer it the whole income of the corporation derived from lights has to be broken up into one-sixteenths of a penny, and allotted to each lighthouse passed in each voyage of each ship that has entered each port in Ireland during the period, and in some instances a reduction has to be made on every sum throughout, in consequence of some alterations in the rate of dues.

New model of Lightvessel.

Vol. II. 406. Personal observation.

Preparation of Financial Returns. &c.

Vol. II. 229, 230. 26-27. WICKLOW HEAD—Nos. 132-133.

and anchored for some hours to visit the lights there. Landed and walked about a mile to the upper light. It is fixed, has fifteen 24-inch reflectors in two rows. They were well polished, but dented in many places. They were first placed in 1818. The keeper has been many years on this station. The old light tower was struck by lightning some years ago.

It had no conductor. The new tower has no conductor either, and the keeper says that in thunderstorms the lightning is "fearful," "it appears to play through and about the whole lantern." There are no meteorological instruments; the clock had stopped the printed regulations were missing at first, and on being found were nearly illegible, and without date. The lower light is close to the sea, and the two are so placed that when the upper is hid by a hill, it is time to keep off shore.

There are 15 24-inch reflectors fixed in two tiers. They were well kept, but more scratched than reflectors in other first-class lighthouses. Only one reflector and the half of another can be seen at the same time by passing vessels. At the Tuskar, where this keeper had been, there are seven reflectors in each of three faces. At Lundy there were nine reflectors on the same face, which only produced as much effect as one-eighth part of the light of one lamp placed in a lens. It follows then that a fixed light on this catoptric principle, showing only one ninth of the light shown at Lundy, cannot be so good as a lens.

Lightning conductor wanted.

Comparison of Dioptric with Catoptric apparatus.

The Commissioners, accompanied by several gentlemen connected with the office, visited the buoy establishment. Captain Ryder made the following remarks.

Visited the buoy wharf at the end of the North Walk. Saw buoys of various descriptions. The Dublin Board have a few Herbert's buoys, but consider that Mr. Bindon B. Stoney has invented an improvement on Herbert's. The inventor calls it the "keel buoy." The keel consists of an iron rim about 18 inches in depth, perforated with a few holes to let the air escape. "The enclosed water," he said, "steadied the buoy by its inertia." "The pressure of the tide on the lips or keel keeps the buoy upright, provided the point of attachment of the chain is rightly placed, and the keel acts as a ballast." The buoy is made in Dublin for half the price of a "Herbert." A 16-foot buoy shows 12 feet out of water. Mr. Stoney said Mr. Herbert had partially abandoned his theory, "and lowered his point of attachment from the centre of gravity and floatation to half way between that point and the centre of the base." *Mr. Herbert subsequently took legal proceedings against Mr. Stoney for infringing his patent.*

Captain Roberts, in charge of the marine establishment, stated that he used stone sinkers on sand, and iron sinkers on rock, because the stone sinkers did not sink so deep in the sand, or oppose so much resistance to the weighing; also that chains wear more on a sandy bottom than on rocks; that there is no oscillating motion in water 15 feet below the surface.

The spare buoys are kept at the lighthouses, and the head-keepers have orders whenever a buoy is displaced to employ boatmen to replace it. (*Note.*—July 19. No buoys have yet been seen at any lighthouse.)

He is not aware of any site requiring a lighthouse in Ireland besides those already agreed on.

The pay of the floating light men was raised in England 10 per cent. when the provisions were high a few years since, and was never lowered. The Irish pay was never raised. The great advantage of rollers in hawse-pipes is that they not only ease the "heaving in, but can easily be shifted when worn, whereas the hawse-pipe, which often suffers in a heavy gale, must be shifted, which is a long and expensive proceeding."

The Dublin Board had accumulated 100,000*l.* to enable them to pay expenses of staff out of the interest, and then to lower or abolish the light dues, but the Board of Trade preferred to take 100,000*l.* into their own keeping.

The chains are carefully tested, but Capt. Roberts considered that the screw steam tender, lately purchased by a grant from the Board of Trade of 4,000*l.*, is too small to lay out heavy buoys on the NW. coast of Ireland. In this the Commissioners entirely concur, having seen the vessel, and the buoys she is intended to carry. She only goes seven knots.

buoyage system. Captain Roberts visits all lightvessels and buoys at short intervals. The channels at Dublin are buoyed on a system, but he does not think it can be applied to passages among banks, as on the east coast of Ireland. The system is red on port hand, on coming in, black on starboard hand.

At sunset steamed for

the board. A similar bell is used on Kingston Pier. The keeper said that the machine was easily wound up (it was tried and found to be so) and worked well, and that the bell was heard 14 miles down wind, though but a short distance to windward. It was sounded for an experiment as the "Vivid" started, and was heard off the deck about half a mile to windward against a slight breeze. It was the largest bell and the best yet seen or heard at a lighthouse. There is no gun.

At 11 p.m. five lights, all burning brightly, were seen, namely,—the Kish, 3 lights, Baily Houth, fixed, Kingston Pier, revolving, the Pigeon House, and the light at the Buoy Wharf on the Liffey. This makes ten lights inspected, and seven others seen, within 36 hours since leaving Milford.

July 13th. At anchor in Holyhead Harbour. Landed at 7½ a.m.; drove to the

Cruise of the Vivid.
Fog signal.
17 lights seen in 36 hours

32. SOUTH STACK.—No. 77-78.

ENGLAND

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It is on an island, under a cliff, and joined to land by a bridge. The sea birds are preserved as a natural fog signal, and are tame. Gulls sit on the walls and close to the lighthouse, and scream continually; a few white rabbits sat amongst the young gulls, and seemed on terms of perfect intimacy. A boat is suspended some 20 feet above the sea at the end of a long rope. The light is revolving, 21 reflectors, which are 50 years old but in perfect condition except where damaged by bits of glass from broken chimneys falling on them. There is not a scratch to be seen that seems new; the reflectors are set on three faces of seven each; the system revolves in six minutes, and shows a bright light every two minutes.

Fog signal, birds.

There is a fog light which is lowered on a railroad to within 50 feet of the water. It has three reflectors and revolves. The keeper was formerly at the Smalls for 14 years, and "liked it well." His father was there before him; he spoke of it with regret. He keeps, 1st, oil and store book, 2nd, meteorological register, 3rd, journal of observations on lights visible, 4th, visitors' book, 5th, order book; all in order. He has, 1, clock, 2, sun dial, 3, barometer, 4, thermometer, all in good order. For his own amusement, he draws, photographs, makes models, keeps duplicates of meteorological observations. The assistant had hurt his arm badly, so that the upper man had to do all the work. There is a large fog bell *inverted* which is rung by machinery. There are no guns used here, but guns are fired from the mountain above in thick weather every half hour, and often when the mails are expected; and the birds are preserved as a natural warning to ships, and have proved useful in fogs. The guns are heard in all weathers nine miles off at the Skerries. The bell never. It seems desirable that the water supply laid on during the building should be continued, and repaired for the keepers, so as to save them the great labour and loss of time consequent on ascending the steps and going to a considerable distance for water.

Fog signal gun

The Commissioners have heard with regret that this intelligent keeper has since been killed, as is supposed by the fall of a stone from the cliff.

Returned to Holyhead. Breakfasted and steamed to

Vol. II. 262. 29. BAILEY HOWTH.—No. 197.

Landed on the rocks, and ascended by steps cut in them. The pier light at Kingston was not lit till some time after sunset. Houth light is a very fine establishment, and in very good order. It is a fixed catoptric light of 17 reflectors, which were well kept, but were dusty, in consequence "of the work of the painters, who had been in the light room all day."

There is a very powerful bell attached to this light, sounded by machinery, which goes while winding, invented by Mr. O'Reilly, the assistant secretary of

33. THE SKERRIES.—No. 79.

Vol. II. 104.

This is built on a low island of some extent, covered with birds, mostly terns, which are preserved. No other fog signals are used here, but mariners can determine their position by distinguishing the noise of the birds which frequent these two stations. The keeper has known fogs to last 48 hours, and a wreck has taken place on the mainland after six hours' fog. There is a sound two miles broad within the island which is dangerous, but which is passed occasionally. One ship, the "Regulus," was

Fog signal, birds.

Cruise of the Vivid
—
Rats.

wrecked on the island four years ago. Rats escaped from her; they have bred on the island, and are gradually destroying the birds. A cat has been tried, but she preferred birds to rats. A man at Holyhead undertakes to kill them all. The light is D. 1st order, fixed, and is in excellent order. The same books and instruments are kept as at the South Stack, all in good condition.

Mr. Baily, who lives at Milford, is the agent for this and all intervening lights; he visits two or three times a year.

Catoptric and Dioptric apparatus compared.

This lighthouse has a tender, which comes off, weather permitting, once a fortnight; she is under charge of a Holyhead pilot. The keeper stated that large glass chimneys were less liable to break than small ones; that the supply was unequal in quality, many were useless (because too narrow below). He has reported this fact to Mr. Baily. He has plenty on hand, but this should be remedied. Sometimes of those which he could use three would break in one night; sometimes one would last for a year. He has been on this station for four years, and has never known his lamp to go out. He was formerly at a reflecting light. He says there is much more labour about cleaning reflectors, but much more watching about a lens light. One of many lamps may go wrong without serious injury to the light; but a single lamp requires constant watching and great care. (This statement is incorrect as regards a fixed catoptric light, for if one of a circle of lights is extinguished, so much of the horizon will be dark.) He thinks that darkened metal fittings similar to those in the lantern would not diminish the usefulness of the light in any way, and would save labour and avoid the risk of damaging the glass of the lens, which is inseparable from cleaning bright metal fittings close to the angles of the prisms. His lighthouse was in beautiful order, but he apologized for its condition, and explained that it was not so clean as it should be "because 250 school children and their teachers visited the island yesterday from Holyhead in a steamer." They drank half a butt of water (which is scarce), and would put their fingers "on the brass work." The birds which kill themselves against the lantern are starlings, thrushes, blackbirds, larks, linnets in flocks, and ducks occasionally.

The glass of the upper prisms in this lens is of English manufacture; it is streaky and far inferior to the rest of the lens. This establishment was considered to be the best, as a whole, that has yet been seen, and it was kept in exceedingly good order. The five glasses used for testing neighbouring lights are here insufficient. "The light at South Stack could often be seen through six or seven such glasses."

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Liverpool, 8
lights seen.

On leaving this light the vessel ran in to Liverpool. The observations of the Commission on the lights under the authority of the Corporation will be found amongst the returns from local authorities under the heading "Liverpool."

On leaving Liverpool the "Vivid" ran for the Isle of Man.

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42. THE CALF LIGHT—No. 83.

was observed from a distance of about 20 miles. Also,

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43. DOUGLAS HEAD.

For remarks on Douglas Head and other lights visited in the Isle of Man, see the returns from the local authorities under the head "Isle of Man," and page 44 below.

The light has lately been transferred to the Commissioners of Northern Lighthouses.

July 16th.—Steamed for

high tides. It shakes very much in heavy weather, and the spray goes over the house.

The head-keeper was on shore on leave with his sick wife, leaving a substitute, who is paid "a shilling a night and his meat," and the under keeper in charge. His name is Stapleton, a powerful man, who said that the only thing he has to find fault with is, that the boat comes only once a week. The provisions are often stale, and all the keepers suffer in health. They have no medicine chest. They have a library, which is changed once a year.

There are 10 reflectors set in two faces. They were in good order, but were not yet cleaned up. The cleaning leathers and boxes for materials were not in a very cleanly condition; but generally the lantern was in good order. There is no ventilation, and the keeper says that the glass inside "fogs," and has to be cleaned daily. The bars of the lantern are very thick. There is no lightning conductor, and "the lightning plays round the tower fearfully." They thought that it broke a pane of glass below some time ago, "it seems to go all round and through the lantern." There has been some talk of putting a conductor, and mending the outside rail (which is of iron, and much corroded and broken in many places) for some years past, but it has not been done. There is a thermometer and a clock, going. There are two fog bells, but they are "no use unless quite close." The Calf of Man, and Mull of Galloway lights are seen from this station. No observations of them are taken. This light was extinguished this morning at 3½. It was visited on May 12, by the Lighthouse Board. They came twice a year in a steamer. There is but one wooden ladder for mounting this tower; if it were broken or lost, it would be hard for the men to descend. Metal steps should be fixed in the stone as elsewhere. The Commissioners had some difficulty in gaining an entrance, as the men, having extinguished the light, had gone to sleep, and the ladder was hauled up. It was only after much shouting that the keepers were aroused, and the ladder let down. They have flag signals, and a tender is attached to the lights.

The birds killed against the glass are blackbirds, *Birds.* stares, thrushes, larks, linnets, woodcocks. The keepers catch a few fish off the rocks. Steamed to

45. COPELAND.—No. 184.

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It has 27 reflectors, in two rows, in very good order, well cleaned, no scratches to speak of, though about 40 years old. The keepers are, John Doyle, aged 57, 24 years in the service, formerly a stone mason; he has been 10 years at Eagle Island, some time at Mouth, and Pier Head, Kingston; not in good health; has no medicine; he has some children.

John Kelly, 27, six years in service, sailor. He also complains that he is "bound up," and would like to take medicine sometimes. There is no lightning conductor, and the lightning "plays all round the lantern." There is a thermometer and a clock (out of order); they take their time by the sun and the almanack; they have no dial. They are generally visited twice a year by the authorities, the superintendent comes at the same time. They have a very large fog bell worked by machinery. It has been heard about 13 miles off at Carrickfergus. The establishment is on an island of considerable size on which cows graze. There is a well of fresh water, an excellent garden and some flowers. The wife of the head keeper lives with her husband, she is from Dublin, and the whole establishment was in a very good state both of cleanliness and efficiency. *Birds.* Birds killed,—blackbirds, thrushes, stares, larks, linnets, ducks, widgeons. On leaving the island steamed for the

Medicine chest.

Clocks and dials.

Birds.

IRELAND.

44. SOUTH ROCK.—No. 186.

Vol. II. 256. This is a low tower built on a rock; the sea covers it at high water, and comes 18 feet up the tower at

46, 47. MAIDENS.—No. 181, 182.

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These are built on two rocks about half a mile apart, and eight from the shore. Landed at the

southern light. There is a dark red stripe painted round these lighthouses. This change is praised in the "Sailing Directions." There are 26 reflectors in two rows, they are 30 years old, and are beginning to wear through; they were in very good order, so were all the cleaning boxes and leathers, each material kept separate from the others; they break from three to five chimneys a week. There is no conductor. The lightning is "very heavy." There are no fog signals, no signals of any kind. The clock is out of order, "it was sent to be mended and made worse."

There have been no accidents at this establishment. The keepers saved a ship's crew who were wrecked, by giving them ropes to get on to the island.

Head keeper, Alexander Power, 52, has seven children; served 16 years, was a farmer, has been at Wicklow Head; appointed by Mr. Halpin, through influence of Col. Latouche; has good food and good health. Gets water from shore; it is stored in barrels and tasted bad; has no medicine; has a library; "has not seen clergy for four years;" "has a boat of his own" for the use of the boys to catch fish. They catch fish also off the rock. The under keeper is Charles Page, born on the northern rock, has good health, has served on the north west coast.

A few duck and teal are killed, but seldom. This establishment (tower and both dwelling houses) is a model of cleanliness. It is well kept and efficient. It was noticed that the thick bars of the lantern were opposite to the lamps of the upper tier of reflectors, which must stop a considerable quantity of light.

Did not visit the other rock, time and coals beginning to run short. It was thought that a buoy was wanted on Allen rock.

48, 49. RATHLIN.—No. 179, 180.

Anchored in Church Bay, and crossed the island to the new lighthouse. It is built of grey stone and coloured dark red near the top.

The American returns received at Liverpool, mention that lighthouses there are coloured with reference to the back ground, those projected against the sky being coloured dark. The evidence of Mr. MacIvor's captains is in favour of this system; so is the evidence of the 793 mariners, the majority of whom state that they can best discern black and red buoys on the water. (See table of experiments, page 10.) The illuminating apparatus consists of two first class dioptric lights, one below, level with the ground, fixed; the other above on the tower, intermitting. The upper light is obscured by a metal tube, which closes round the light for 10 seconds, and remains open for 50 seconds.

The keeper considers the machinery too complicated for so simple an object; it has been out of order; it goes for five hours and a half, and is easily and quickly wound up. The ventilation of the lower lantern is defective, the glasses are apt to become clouded at night. The frame work is bright, and the keeper considers that it would be an advantage if it were dark metal. In cleaning the metal, it is difficult to avoid soiling the glass of the lenses. The glass was made by Chance. The colour is good, but it is somewhat streaky. The keeper thinks a lens light much easier to manage than a reflecting light, much less troublesome. The American lights are now all dioptric. (See American return, and the reasons there given.)

There are no meteorological instruments. There is a clock. There are no fog signals. No observations are taken of the lights visible, namely,—Ceantire 13 miles, Islay 30, and Instra Hull. The fog seldom settles on the island. The head lighthouse keeper complained that when the change of currency took place, no alteration was made in their salary, which was measured by guineas; that they thereby lost 1s. 8d. in the pound. He thought the English light-keepers were better paid, although their provisions were no dearer.

The head keeper had served at Fastnett, &c., in both catoptric and dioptric lights. There are three keepers, one of whom is on leave. The under keeper has been at Fastnett, South Rock, Eagle Island, Tory Island; he is the son of a lighthouse-keeper, and was appointed by the superintendent of lighthouses without any influence. Both are married; each has his own dwelling; everything was in excellent order, neat, clean, and in a high state of efficiency. It was not ascertained whether there was a lightning conductor, or a medicine chest, the two articles generally deficient in Irish lighthouses, and which seem to be most required.

This light has been exhibited since 1856, and no birds, birds have been killed against it since this keeper came, eight or nine months ago. Called on the proprietor, Mr. Gage, re-embarked and steamed past the Giant's Causeway, took a pilot at Innishoven, and ran up Lough Foyle to Londonderry, anchored at a quarter to nine. The observations made on the lights, &c. in Lough Foyle will be found under the head LONDONDERRY, *Irish Local Returns*.

The following evidence was obtained July 18. After the minutes were read and signed, and while the secretary despatched correspondence, the Commissioners went ashore. On board the "Rose," a steamer belonging to the Glasgow and Derry Company, was found the commander, Mr. Michel McLaughlin; he stated that great difficulty is experienced in distinguishing the two lights at Innishoven, which are under the Ballast Board; the inner light should be raised 20 feet, or the outer one lowered the same distance. A light on the west end of Rathlin Island would be serviceable, but one on Sheep Island would be better. A light on the south side of Rathlin would be useful. He considers the Clyde well lit and buoyed, but the red light on Sanda Island very indifferent.

Mr. W. Johnson, commanding the "Enniskillin," a Liverpool and Derry steamer. He agreed with the preceding as to the change required in the Innishoven light; he thought a light on the Sheep Island most desirable for ships navigating the Rathlin Sound; also that the lighthouse should stand on the North instead of the South Rock, and that there should be something to mark the Highland Rock among the Maidens. He always makes the north-west light-ship in approaching Liverpool, and sees the Bidston light afterwards. Bidston light ought to be as good a light as can be made. A lightvessel outside, where the Bell beacon buoy now is, leaving the buoy in its place, would be of the greatest possible service. No greater improvement to the Liverpool navigation could be devised. The Forinby light is very bad. The lighthouse should be on the Chickens instead of the Calf of Man. (See Liverpool return.)

Captain S. A. Bedford, R.N., commanding the survey of the north west Coast of Ireland, was sent for, confirmed general statement, that the inner light at Innishoven should be raised; that Arranmore light should be re-lighted. He referred the Commissioners to his evidence published in the small volume of the report of the Royal Lighthouse Commissioners. Had addressed Ballast Board on subjects connected with improvement of navigation, but received no answer, and is never commonly seen by them when they visit the coast, nor is his advice asked although his experience extends over so many years. He stated that at a very small expense many of the harbours might be made accessible at night (see his answer, Mariner's Evidence, to 13, 15, 16, 23, 19, his own index number 13), decided in favour of lighthouses varying in colour according to the background.

Mr. Richard Hosking, Master R.N.—N.E. survey of Ireland, confirmed statement that inner Innishoven light should be raised, as also great value of lights on Sheep Island. See his answer. Is never consulted by Ballast Board. Says many of the buoys are inaccurately placed, in some cases within the dangers

*t ruize of the
Virid.*

*Colour of
buildings.*

they are meant to warn navigators off. Says there are many inaccuracies or ambiguities in the Admiralty's book of lighthouses. Considered that iron buoys off Loch Foyle should be under the Ballast Board. Confirmed general view that the colour of a lighthouse should depend upon background. Expressed a strong opinion against too numerous variations in the exhibitions of lights stating that the common run of seamen will be puzzled. Objected to the "fixed and flashing," stated that the fixed portion is only seen when close to. Lighthouse book should always state when there are two lights whether they are in the same tower or not.

At the office of the Londonderry Harbour Commissioners were seen Mr. Abraham Stewart and Mr. Jas. McGee, the harbour master. The "Tuns" buoy goes adrift about once a year, and it has sometimes been a month before it could be replaced. There is no spare "Tuns" buoy, but when adrift it is replaced temporarily by a smaller one; it is indeed in contemplation to substitute permanently a smaller buoy on account of the immense strain on the cable. "No lightship could ride at the place of the "Tuns" buoy." They agreed in the opinion given above of the Innishowen lights; the small third light was added because complaints were frequently made, whereupon they wrote repeatedly to the Dublin Board, and at last the third light was added, but it is of little use.

July 20th.—Got under weigh about 3 a.m., and at 5.30 landed at

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52, 53. INNISHOWEN—No. 177, 178.

This lighthouse was built about 1824. There are two towers, which are exactly on the same level. The lights are therefore seen as one by vessels running in for the harbour.

*Two towers
objectionable.*

This has been much complained of, and a single lamp and reflector has been placed in a window in the outer tower. The light being on the same level is doubly objectionable, for vessels, when they open the lights, cannot be sure whether they open from the one side or the other. (See evidence above.)

The inner tower has three reflectors. These and the cleaning boxes were in good condition. The lamps have no iron chimnies. There is no conductor. The keeper's name is Anthony Hicks who has been here 22 years, he has been 34 in the service, he is married and has grown up daughters. He was a printer in Dublin. He has been at Eagle Island and Cape Clear. There is but one keeper at each tower. This one says he is getting old and would willingly resign. His place was all in good order, very neat and clean. His family help him in the duties.

The outer tower has nine reflectors fixed. The main bar of the lantern is placed nearly opposite to the reflectors in one row, and must stop a great deal of the light. The lamps in both lights are on a different principle from those common elsewhere, they have a button in the centre of the wick called a "deflector" for throwing air into the flame.

Reflectors and cleaning boxes all in very good order; dwelling house the same; all metal work polished brightly. Powders and leathers in their proper places. The keeper's name is Hugh Redman, 70 years old, 56 in the service, has been all round the kingdom, has never been a day sick, he has raised 13 or 14 children. The reflector in the lower window was in good order. It seemed that three would be of more service, and these could be easily added by enlarging the window.

The wife remembers the loss of the Rambler on Allen Rock when she was at the Maidens. Steamed for

mile from the main land. Sighted Fannet Point lighthouse. Steamed for the Rhinns of Islay. Landed at

55. OVERSAY ISLAND, RHINNS OF ISLAY—SCOTLAND. No. 93.

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and inspected the lighthouse. There are 24 reflectors revolving, showing a flash from three reflectors every five seconds, built about 1825 or 6. The lamps have no iron chimnies. Reflectors, cleaning boxes and lantern generally in good order. Clock going well in the lantern. There are three keepers, and there is a signal bell which rings in each dwelling by blowing into a tube in the lantern. There is an answering bell in the lantern which was rung and was efficient. The oil burned is colza, and is stored in a cellar underground. The oil is run in from outside through a tube which has a cock opposite to each vessel.

The instruments kept are, clock, barometer, thermometer, thermometer in oil cellar, rain gauge, (five,) all in a state of efficiency.

The books kept are,—Monthly Return, General Order, Shipwreck Return, Inventory, Postage Book, Visitor's Book, (seven,) all in order. There is a book of regulations, and one on the barometer, and there are a number of religious books provided. The "Illustrated London News" and the "Leisure Hour" are supplied to the keeper by the Board. It was remarked from the sea that the colour of the lighthouse (a light brown), rendered it difficult to distinguish from the hills and rocks behind. There is no lightning conductor, and there are no fog signals. Each dwelling has a medicine chest. The head keeper is married and has 11 children who go to school on the mainland; he has 47*l.* a year, cow's grass, 3*l.* for a policy of insurance, gardens, and a suit of clothes once in three years. The inspector, David Scott has been twice this year, in April and July. It was remarked that the lantern bars were properly placed, and that the blinds had spring rollers.

Took in a Portnahaven fisherman as pilot, and steamed for

DUBH-LARTACH.—(Black Western.)

This rock has been thought a fit situation for a lighthouse, and a correspondence on the subject has been forwarded by the Commissioners of Northern lighthouses. It begins with a memorial dated October 25th 1855, from Archibald MacDonald, Guide to the ruins of Iona, in which mention is made of wrecks which are supposed to have taken place on the rock, and the facts on which the supposition is founded. The Scotch Board directed their engineer to report on the subject, and in 1857 an unsuccessful attempt was made to visit the rock. On the 1st July 1857 a report from Mr. Stevenson was read. Information as to wrecks is given, the position of the rock and the danger to navigation is pointed out, and it is stated that the engineer had in vain endeavoured to effect a landing even in calm weather. The reporters add, "We have no hesitation in reporting that the erection of a lighthouse upon it would be a work of no ordinary magnitude."

The Skerry Mhoire is pointed out as a parallel case. The Commissioners delayed further consideration of the subject till they should have an opportunity of visiting the rock on their annual voyage of inspection.

On the 20th May 1859, Captain Bedford of the Admiralty Survey reported a case of supposed wreck on this rock, and the report of the engineers in 1857, contains a list of 32 wrecks on the neighbouring coasts of Colonsay and Iona, of which 29 took place since 1803.

On the 20th June 1859, the Commissioner, landed on the rock without much difficulty; but though the weather was fine there was a considerable swell on, and probably a landing cannot often be effected so easily. The rock is of considerable size and always

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54. INSTRAHULL.—No. 176.

Found the surf too heavy to land. The light is built on an island of considerable size, at about a

above the level of high water. The boatman stated that in a moderate gale the waves break over it, he has landed there three times and has seen the waves breaking over the rock on other occasions when passing to or from Barra. He says that every spring the people of Mull go out to Dubh-Iartach and pick up such articles as silver spoons, ship's chains, and other heavy things, proving that wrecks have taken place. There is a reef which is dry at low water spring tides, and which runs out to seaward for a considerable distance. The outer end of this reef is low, but is generally out of water. It is presumed that vessels strike on the outer end of the reef, and when broken up, that heavy articles are thrown over and lodge in the holes in the lower part of the reef, where they are found almost every year. Similar stories were told of the Skerry Mhoire. The rock is better as a foundation for a lighthouse than those on which the Scilly Bishops, and Smalls are built. It is evidently a very dangerous reef. Specimens of the rock were taken. It is an igneous rock, hard and compact.

On leaving, steamed for Oban. Observed the lighthouse at

56. RHU VAAL—No. 94.

showing over the outer end of Oronsay for a considerable distance from the point. Read the correspondence on this subject forwarded by the Commissioners of Northern Lighthouses, and studied the chart so as to understand the question which has been the subject of much correspondence.

The following is an abstract. It comprises 68 letters and 191 MS. pages, and extends from 1853 to June 1st, 1859. It begins with an excerpt from the engineer's report of 1834.

The proposed light is there described as one of a series of lights intended to open up the sheltered passage along the coast of Scotland inside the islands.

The Commissioners, in November 1853, reported in compliance with a letter from the Board of Trade, from which the following quotation is made,—“24th August 1853,”

“with regard to new works, it will be necessary that a detailed statement should be made of those works which the Commissioners consider to be most pressing, with an estimate of the whole cost of the works.”

In this report the Commissioners mention “a first-class light near Portaskaig, in the sound of Islay, so placed as to open the sound fully both to north and south, cost 11,000.”

Together with their report the Commissioners forwarded excerpts of their proceedings, and of the reports of their engineers on each of the sites named.

On the 1st day of December 1858 the Commissioners informed the Elder Brethren of the Trinity House of the resolutions to which they had come, and mentioned the light at Portaskaig. And, on the same day forwarded a copy of their letter to the Board of Trade, together with further documents.

On the 14th of December, the Trinity House acknowledge the receipt of this communication, and asked to be informed of the amount of tonnage which was calculated to derive benefit in each case from the proposed lights.

The calculations were furnished as requested.

On the 11th of January 1854, the Trinity House replied, and on this point said “That the light at or near Portaskaig, in the sound of Islay, would only be useful to vessels passing through “that sound, and should therefore be considered as a local light, and the toll to be imposed be chargeable accordingly.”

The Elder Brethren, having stated their opinion, added, that “in the event of the intended erections, or any portion of them, “meeting the sanction and concurrence of the Board of Trade,” they would take an early opportunity of visiting the localities, for the purpose of forming an opinion as to each site.

So far then the Trinity House offered no objection to the site, or to the nature of the proposed light near Portaskaig, and their views as to the charges agreed also with those of the Commissioners of Northern Lighthouses.

On the 27th of January 1854, the views of the Trinity House were stated to the Board of Trade by the Commissioners of Northern Light Houses, and their views were stated also. It was pointed out that under the 16 & 17 Victoria c. 131, the Trinity House had only to consider the usefulness of the proposed lights, and not the question of tolls.

On the 11th of April 1854, the Board of Trade transmitted to the Commissioners a report forwarded to them by the Admiralty, and sent to the Admiralty by Commander Bedford, the surveying officer in the district, relative to the establishment of a lighthouse in the sound of Islay, “upon that point called Carrig Mhoire, “situated about half a mile southward of Portaskaig,” which site, Commander Bedford considered to be the best, as being visible from the greatest distance north and south, and for other reasons.

And on the 11th of May, the letter of Commander Bedford sent to the Admiralty, and by the Admiralty to the Board of Trade, and by the Board of Trade to the Commissioners of Northern Lighthouses, was communicated by the Commissioners to the

Trinity House, and it was pointed out that as regards the Lighthouse the matter awaited the sanction of the Board of Trade, to whom it was referred on the 1st of December, five months before.

Their Lordships were reminded on the 12th of April, and,

On the 11th of May the Commissioners of Northern Lighthouses expressed a wish that in the event of their proposals being sanctioned their Lordships would cause them to be informed within a short time, so that steps might be taken for proceeding with the work in the course of 1855.

On the 23rd May their Lordships concur in the opinion expressed by the Commissioners that no time should be lost in making such preparations as would not interfere with any changes in the selection of the sites, which, after the visit of the Elder Brethren, it might appear expedient to make.

And on the 25th of August 1854, the Trinity House communicated to the Commission the result of the observations made by a Committee who had visited the proposed sites.

As respects the proposed light at Portaskaig, the Committee did not approve of the site chosen by the Commissioners, and suggested by the surveying officer on the station in his letter to the Admiralty. They stated their objections, and suggested Rhu Vaal, at the north end of the sound as a better position in the meantime when a redetermination was made to the sound of Islay for the sound to the westward.

On the 8th of August 1854, the engineer of the Commissioners reported on the letter of the Trinity House, and with reference to light at Portaskaig pointed out that the objections of the Elder Brethren to the site selected by him and by Captain Bedford independently, were well grounded, as it seemed impossible to light the sound efficiently with a single central light. That a light at Rhu Vaal would open up the northern entrance to the sound of Islay, but that it was doubtful whether it should be used to light the intricate and dangerous passage between Oronsay and Islay.

It was also pointed out that the question of a light for the southern extremity of the sound of Islay had not been decided.

On the 11th of August, the Trinity House were informed that orders had been given for the necessary surveys of all the proposed sites.

On the 11th of October, Captain Bedford wrote to the Commissioners, urging on them a reconsideration of the choice of Rhu Mhaol, and again recommending the site near Portaskaig as the most eligible, on the supposition that only one light was to be established in the district. Captain Bedford's views were stated at length, and with respect to the west, the danger of making the light visible in that direction was stated. The engineer, on reading this letter, had nothing to add to his former report, but

On the 2nd of November 1854, the Commissioners directed a copy of Captain Bedford's letter to be sent to the Trinity House.

On the 8th of November the Elder Brethren called attention to their former letter as explaining their views.

On the 10th of November, the engineer reported on several sites, including Rhu Vaal.

On the 14th the Board of Trade requested that plans, &c. should be sent.

On the 29th the secretary to the Commissioners stated to a meeting that he had forwarded a copy of Captain Bedford's letter to the Board of Trade, and read the reply dated 18th November 1854, in which their Lordships pointed out that they saw no reason to depart from the view taken by the Elder Brethren.

On the 29th November Captain Bedford was so informed.

On the 14th of December 1854 the Trinity House returned the plans sent the Commissioners by the Board of Trade and by that department to the Trinity House, with a letter, in which is the following passage, “together with a memorandum containing “their Lordships' approval of these plans, subject to the observations contained in the said memorandum, and “having requested that, since any suggestions to be made to the “Commissioners should in accordance with the Act 16 & 17 “Victoria, c. 131, sec. 21, be made through this Board, the Elder “Brethren will, if they agree with their Lordships' suggestions, “cause the said plans and memorandum to be transmitted to the “Commissioners, to which request their Lordships add the remark “that they take this step in the present instance in preference to “the obvious course of having the plans sent for the observations “of this Board in the first instance, and before their Lordships “express their opinion, because the plans are already in their “Lordships' hands, and because it is of great importance to avoid “unnecessary delay, and the Elder Brethren, having adopted their “Lordships' suggestion, and having given the plans and memorandum due consideration, I am directed in transmitting them to you for the Commissioners' information the views of the Elder “Brethren in relation to these respective sites, as follows:—

The Elder Brethren reserved the “character of Rhu Vaal and “other lights for future consideration; the memorandum of the “Board of Trade,” suggested to the Trinity House, and adopted by them, has this passage:

No. 9. Rhu Vaal, Sound of Islay. North end site approved. “The light to be made to serve as a clearing mark for the “Nevea Rocks. Initialed, P. H. F.

So far then it appears that all parties except the surveying officer were agreed as to the propriety of building a lighthouse on Rhu Vaal, and that the Board of Trade, in the case of the lighthouses referred to in their memorandum, originated suggestions which were adopted by the Elder Brethren, and approved of by the Commissioners of Northern Lighthouses, in particular a suggestion as to the light now under consideration, which was directly opposed to the opinion of Captain Bedford, considered of doubtful advantage by the engineer, Mr. Stevenson, and referred to by the Committee of the Elder Brethren who visited the locality, in their letter of the 2nd August 1854, in these terms:

“It remains further to notice in connection with this subject, “the channel between Oronsay and Islay for which a light on “Rhu Vaal might be in some degree useful, but it is bound on “both sides with rocks, which extend considerably from the shore “and a light on Rhu Vaal could not be sufficiently screened to “guide vessels clear of those dangers.

On the 24th of January 1855, a correspondence relative to the sites commenced, and the result was communicated to the Board of

Cruise of the Vaid

Wrecks.

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Abstract of correspondence and remarks.

Cruise of the Vivid.

Trade, and their Lordships communicated their views as to expense.

On the 11th of April 1855 plans were transmitted to their Lordships.

On the 1st of June their Lordships requested that the Northern Lighthouse Commissioners might be informed that, "after consulting with Mr. Stevenson, and obtaining accurate information on the subject, they were satisfied that if the proposed light at the Sound of Islay is intended to show in the direction of the Neva or Balach rocks a tower 100 feet high, as shown in the working plans, must be provided for, it will be sufficient for the light to show as far as W.N.W. only."

Their Lordships also suggested that a window might be provided low down in the tower, in case it should hereafter be found possible to render the channel to the Sound of Islay navigable to coasters.

On the 25th of June the engineer sent in the tenders received, and pointing out that the increase in the height of the tower would cause increased expense.

On the 28th the Commissioners caused their Lordships to be informed that the engineer had intended, "in consequence of the determination of their Lords to cause the light of Rhu Vaal Islay to be shown towards the westward, as far as the direction of the Neva Rocks, it was found necessary to design a tower 100 feet in height, which was not in the contemplation of the engineers, and therefore a further sum would be necessary, and on the 3rd of July their Lordships sanctioned the extra expense."

On the 12th of February the engineers reported that the propriety of lighting the passage of Colonsay, and exhibiting the light in the direction required further consideration.

On the 7th of May 1856, the Commissioners had under their consideration a copy of a report sent by Captain Bedford to the Admiralty, and decided not to answer it till officially brought to their notice. They also considered a memorandum from certain ship-owners and others interested in the matter, stating their objections to the site on which they observed the lighthouse in progress.

On the 18th of October 1856 this memorial was forwarded to the Board of Trade.

On the 29th it was acknowledged.

On the 3rd of November, the subject of the character of the light was referred to in a letter from the Board of Trade to the Commissioners, and they were requested to furnish plans.

On the 5th the engineers repeated their great doubt as to the propriety of attempting to render the light on Rhu Vaal available in lighting the channel between Oronsay and Islay, and their opinions that the light showing to the westward should be a danger light to warn vessels off.

From this period up to the exhibition of the light a correspondence was carried on amongst the authorities relative to the character of the light.

The Commissioners wished that it should be revolving, and show red to the westward as a warning light.

On the 15th of January 1857 their Lordships stated their view that a fixed light, so coloured as to lead vessels through the channel between Islay and Colonsay, would be better and directed the Commissioners to communicate with the Trinity House.

The Commissioners again stated their opinion to the Board of Trade, and were again desired to state their views to the Trinity House. The correspondence was sent to the Trinity House on the 12th February 1857.

On the 25th of February the Trinity House concurred with the view of their Lordships that the light should be fixed, and remonstrated with the Commissioners on the irregularity of corresponding direct with the Board of Trade. But the Elder Brethren reserved the consideration of the masking and colour of the light.

On the 20th of July 1857 their Lordships "approved of the character of the light proposed by the Elder Brethren, and considered that the red shade should extend from North to N. 48° west true, as shown on the chart sent therewith."

So far then, the governing authority appears to have been the Board of Trade, and the object, contending for the opening of the channel from the westward to which Captain Bedford and the Commissioners of Northern Lighthouses were opposed.

On the 15th of July the Trinity House communicated their view to the Commissioners, "That the light should be a fixed white light visible to the northward and eastward, and to the southward as a guide to vessels navigating the Sound of Islay, visible also to the westward as a warning to vessels to keep off from the dangers abreast of Colonsay and Oronsay, and coloured red only in the direction of the east coasts of Colonsay and Oronsay, and with a view of warning vessels approaching too near these islands, when bound through the Sound of Islay."

The Elder Brethren also stated that they were not prepared to recommend that mariners should be encouraged to navigate the dangerous channel between Islay and Oronsay by night.

The Trinity House then appear to have felt that the proposed measure was not desirable.

The Commissioners of Northern Lighthouses, on the 1st of October 1858, communicated to the Board of Trade as to the sailing directions, and again state their opinions that the arrangement would not prove satisfactory.

Several letters passed on this subject, and on the 27th of October the Trinity House stated their views. The Secretary was directed to inform the Secretary of the Marine Department for their Lordships information.

"That the Elder Brethren having given renewed consideration to the purposes for which this light is to be exhibited, concur in the first part of the paragraph proposed by Captain Sullivan, but they saw no reason to alter the opinion communicated in the letter of the 15th of July 1857, viz., that should it be found hereafter, upon further survey of the passage, (viz., that between Islay and Oronsay) that it is capable of being rendered navigable with safety during the night, by giving the light a distinctive character to the westward, the adoption of such a measure may then be considered."

"and, considering the dangers which are mentioned, the Elder Brethren were not prepared, in the absence of such distinctive character, to recommend that masters of vessels should, under any circumstances, take a course defined by compass bearings

"alone between the Islands of Islay and Oronsay during the night season."

On the 8th of November the engineer pointed out that from certain positions the red light might be seen over the island of Oronsay, and suggested that the sailing directions should be altered.

On the 4th November 1858 the Commissioners informed the Board of Trade, and further remonstrated against the exhibition of a white light as a danger light, as being contrary to the well understood principle.

On the 20th of November 1858 their Lordships informed the Commissioners that they agreed with the alteration proposed by the Elder Brethren to be made in the paragraph to be inserted in the Notice to Mariners, and also as "to the use of a white light as a warning light."

On the 20th November 1858 the Elder Brethren had explained their reason for advising the use of a white light as a warning in that position was "the light of coloured red to the westward, as proposed by the Commissioners," would not be visible at a sufficient distance.

On the 14th of December 1858 their Lordships intimated that it would have been better if the sailing directions had been stated to have been "proposed by the Trinity House, and approved by the Board of Trade." The light was exhibited on the 1st of January 1859.

On the 20th the Commissioners called the attention of the Board of Trade to an article in the Nautical Magazine, in which the Commissioners were blamed, and pointed out that the attack made upon them, in fact advocated the views entertained by them and expressed to my Lords.

On the 29th of January 1859 a reply was sent in which this passage from the Lords was noticed in the article in question, "make them alter their opinion deliberately formed after careful inspection of the spot by the Elder Brethren of the Trinity House and Captain Sullivan, on grounds which my Lords believe are well known to the Commissioners."

It appears then from this correspondence that the Commissioners of Northern Lighthouses were overruled, and that the character of this light and the light on Rhu Vaal, in the article in question, were all in accordance with suggestions originating at the Board of Trade, only partially adopted by the Trinity House, and directly opposed to the views of the surveying officer on the station, and the Commissioners of Northern Lighthouses.

On the 20th of May 1859 Captain Bedford made the following communication to the Commissioners:

"The most important item of information, has reference to the Islay light, and the information I obtained from the master of the Colonsay mail boat. He says the blending lights are distinctly seen by vessels passing to the westward of Oronsay, that about six weeks since he received information at Portaskaig that two vessels in the above direction, following (I presume) a general understanding, bore up for the Sound of Islay, on passing out of the red into the bright light, and only discovered their error in time to prevent fatal consequences; this should be evidence enough that two vessels, in so short a space of time, on a coast frequented by few, should have been nearly wrecked, by following the usual course indicated by distinguishing colours."

On the 24th of May the Commissioners informed the Board of Trade, with this observation:

"The Commissioners have already represented this matter so strongly to my Lords, that they have no further observation to offer."

On the 1st of June 1859 their Lordships acknowledged the receipt of the letter of the 24th.

The Lighthouse Commissioners after reading this correspondence, and having seen the lighthouse over the land of Oronsay from the westwards, having studied the chart of the locality, and having seen the sea breaking heavily on rocks in the channel between Islay and Oronsay, came to the conclusion that the views of the Commissioners of Northern Lighthouses on this question were just. And they were confirmed in their opinion on examining Captain Bedford subsequently while in the neighbourhood.

Remarks on the case of Rhu Vaal.

See oral evidence.

Ran for Oban and anchored.

July 21st. While the "Vivid" coaled, steamed round Mull in the "Pioneer," questioned the pilots on board, and the fishermen at Iona, and had the account of the Islay Pilot and of Captain Bedford fully confirmed as to the fact that vessels have been lost on Dubh-Iartach. One man at Iona stated that he had himself picked up cannon, which he had taken to Oban some years ago. Called for Captain Bedford at Carsaig, and finding that he was absent left a note for him. On arriving at Oban heard the views of Mr. Hutcheson, owner of many Highland steamers, as to the building of a lighthouse in the Sound of Jura, he was much in favour of the Iron Rock as a site for a lighthouse. Mr. McArthur also expressed a very strong opinion as to the necessity of a lighthouse on the Sgeir Mhaol (Iron Rock). Mr. Hutcheson stated his belief that the present cause of delay in building the lighthouse on the Iron Rock is a question of the expenditure of 3,000*l.* which the authorities at the Board of Trade refuse to sanction. The Scotch engineer estimates the expense at 9,000*l.* including a shore light; Mr. H. was owner of the "Chevalier" lost on this rock.

There are two black buoys in the harbour at Oban, two spare buoys are kept on the beach, and it was stated that these buoys are changed and overhauled every three months. Observed the Lismore lighthouse from the hill above Oban burning brightly, and lit at the proper time.

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57. SKERRY MHORE.—No. 101.

Surveying
officer, Capt.
Bedford.

Picked up Captain Bedford at Carsaie and steamed to Skerry Mhore passing through the Torren Rocks at the end of the Ross of Mull; landed at the lighthouse; it is built on a reef of low rocks larger than the Scilly Bishops. The stone is granite from the Ross of Mull, and the building was pronounced the finest yet seen; a red flag was hoisted to indicate that it was safe to land. It was suggested that this should be altered, as red usually indicates danger. The landing is by an iron ladder, and there are iron ways fixed in the rock from the landing place to the foot of the building. These have withstood the sea, and enable the keepers and persons bringing stores to move about the rock much more easily than elsewhere, where these ways are wanting. The ascent to the door is by a gun-metal ladder instead of by metal steps let into the stone as at the Scilly Bishops, or a loose wooden ladder as at the South Rock in Ireland.

The first story of the building contains water tanks for 1,300 gallons, the second coal tanks for 13 tons, the third is a workshop used for carpentering and other occupations. The fourth story is a store-room; the fifth, a kitchen; the sixth and seventh, bedrooms; the eighth, a library; the ninth, an oil store containing 1,038 gallons; and the lantern makes the eleventh story. The bedrooms are divided into two cabins each, there is a lamp which stands outside and gives light to each through windows. The cabins are fitted with oak, and have large looking-glasses a foot square set in panels; the beds and everything about the rooms were remarkably clean and neat. The library is well furnished with handsome chairs, one from the Bell Rock. The lantern is very lofty, and is surrounded by a gallery with gun metal rail; a dial is fixed on the outside. There is a clock in the light room, and another below, all in excellent order. There is a ladder of gun metal, and a light rail outside the lantern for cleaning the glass; there is a lightning conductor. The illuminating apparatus is revolving, fixed, prisms below, eight panels of lenses revolving, and eight smaller panels also revolving above, to concentrate the upper rays; these are thrown on eight plane mirrors, which deflect them to the horizon parallel to the rest of the beam. The light is, therefore, a fixed light of low power, varied by strong revolving flashes; the lamp has four wicks, and is worked by pumps which ring a small bell while in action. The lamp machinery is wound up every hour and a half, and the keepers wind the revolving machinery at the same time, though it will go for three hours. The superintendent was at the lighthouse the day before to inspect the machinery.

The oil is hoisted up to the top of the tower by a moveable crane. The water is pumped up by a force pump; the kitchen and all the rooms have bell signals worked by blowing tubes, so that the keepers can call each other without leaving the lantern.

There are two fog bells ringing every half minute. These are supposed to be too near the gallery, they are not heard at any great distance, but they were heard on board the *Vivid*, distant about a mile.

There is a signal ball hoisted every morning to indicate all's well; there are other signals for shore, and a book is kept showing them. There is a table calculated for the latitude, giving the hours of lighting and extinguishing for every day, and a picture of the flame at its best, framed and glazed. There are three keepers on duty, and one on shore, James Wallace, married, he has six children: John W. Hall, married, has nine children; William Mail, married, four children. Their families live on shore in Tyree; they have dwelling, and cow's grass, and the children go to school. The men

I.

say that they are healthy, they have a medicine chest, and use mostly salts and castor oil, but of these they take little. Wallace has been at Point of Ayre, Barra Head, and he saw Skerry Mhore Light from Barra Head. He pointed out that the granite, where exposed, is going; on rubbing the fingers on the stone, small particles like sand crumbled away. Where the stone has been oiled it is hard, and no sand can be rubbed off. This was particularly shown in the place where the weight goes up and down, and where contiguous portions of the stone are oiled, and left in the natural condition. The books kept are log book, visitors' book, journal, return of shipwrecks (blank), store book, inventory, (six.) all in good order. There is a barometer and a thermometer; no wind gauge, no rain gauge. There was a machine for measuring the force of the waves, but it was abandoned as giving unsatisfactory results. There is no life buoy, and some of the keepers are unable to swim; in fine weather something of the kind might possibly save life. The keepers catch a few fish, such as little cod and rockfish. They occasionally see seals, and when they come about the rock no fish are to be got. The birds that kill themselves are blackbirds, thrushes, starlings, and once a woodcock; few are killed here. The whole establishment was in a state of complete efficiency, the men clean and dressed in their uniforms, and everything under their charge in first-rate order.

Cruise of the
Vivid.

Fish.
Seals.
Birds.

58. RUADH NA GALL, or SOUND OF MULL.—No. 96.

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Steamed into the Sound of Mull, and inspected the lighthouse at the entrance. It is built on a point of columnar basalt containing agates. The house of brick whitened with stone mouldings. The keepers' houses are at a considerable distance, and there is a roadway over the rocks.

The light, dioptric holophotal, two wicks, red to seaward, so as to distinguish it from the neighbouring light of Ard na Murchan, green towards the opposite shore, and white towards the Sound of Mull. The beams to seaward and towards the sound are strengthened by a series of reflecting prisms which deflect the light which would otherwise shine towards the land and be lost. By this contrivance a light of the fourth order is made equal to one of much greater power, and a greater saving of oil is effected. The keepers are well lodged; the tower is furnished with the usual instruments, viz., clock, dial, telescope, barometer, thermometer, rain gauge, lightning conductor. There is a workroom furnished with tools, and the keepers are provided with a medicine chest, though close to Tobannoray. There is the usual blow tube from the lantern to the dwelling houses; everything in first-rate order. Captain Bedford stated that the green light did not appear sufficiently green from the opposite shore.

Azimuthal con-
densing appa-
ratus.

Instruments.

59. ARD NA MURCHAN.—No. 97.

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Landed Captain Bedford and steamed to Ard na Murchan, landed on the rocks, and surprised the keeper who had not observed the *Vivid*. The tower is of granite and a beautiful building. The dwelling houses are at the foot, and are exceedingly comfortable; there were the usual instruments, and everything was in excellent order ready for lighting. The light is dioptric, first order, with a mechanical lamp fitted with the warning bell. Two large reflectors of silvered glass turn all the light from the landward side towards the sea. The metal fittings were intentionally dark; the bars of the lantern were thin and set diagonally. There are two keepers, Henry Murdoch and William Crouth, both married, the first has no children, and was a farmer, the other has one child, but he has been married only one year.

They stated that the large glass chimnies were not all of one gauge. This has been remarked in all the principal first-order lights visited in England, Scotland, and Ireland. The tower was struck by light-

Keeper's
dwellings.

Glass chimnies.
Lightning.

D

Cruise of the Vivid.

ning some time ago, but no damage was done. The keepers see the light at Skerry Mho occasionally; according to calculation from the heights of the two lights, and the distance, 38 nautical miles, this should be impossible, unless in consequence of some peculiar refraction.

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60. ISLE ORONSAY.—No. 98.

Steamed to Isle Oronsay and observed the light in the Sound of Mull. The beam which is projected down the Sound of the Skye is very brilliant; on entering the beam, which projected northwards towards Glenelg the increase of power was very marked, and on entering the harbour the light disappeared suddenly at the point indicated by the drawings in Mr. Stevenson's Book. At 5 A.M. landed at the lighthouse. It is the same in principle as that in the sound of Mull. The illuminating apparatus is of the same description. The only variety is in the number of prisms and size of the lenses for the additional beam which are calculated according to the distance at which it is desirable to see the light. There are seven prisms to the north, and twelve to the south. This light and Ard na Murchan can be seen together.

Both keepers are married, the one has four children the other six. Both have been in the service for a long time. The whole establishment appeared to be in a state of complete efficiency, and there were the usual books, instruments and furnishing.

The birds killed here are larks and starlings—very few, not nearly so many as at Pladda, where numbers were killed.

Birds.

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61. KYLE AKIN.—No. 99.

Steamed through the narrows to Kyle Akin. It was remarked that some buoys or beacons, or perhaps a small light similar to those in Loch Foyle, would be an improvement, as the narrows are dark for a considerable distance.

Landed at the lighthouse at Kyle Akin, where the keepers were all in bed; roused them and found everything according to the regulations; lamp ready for lighting, blinds down, and everything cleaned up; the usual instruments, &c. provided and in good order. This light has a set of totally reflecting prisms to economise the light and reflect a portion of it to seaward. Towards the sound the light is masked, all but a narrow beam, which acts as a leading light, and clears all shoals. To seaward the light is red, and is masked from dangers and from the shore. It was observed that the bars of the lantern were so placed as to stop a considerable portion of the light, and it was thought desirable, that in future the lens and the lantern should be made and set up together before they are finally placed so as to avoid such imperfections.

The keeper stated that this light gave great satisfaction, and enabled vessels to run in in bad weather, instead of remaining outside, as they formerly used to do, exposed to the heavy sea which sets in from the north. The house is of brick, whitewashed, with stone foundation and mouldings; a bridge joins it to the land. It was well kept.

Azimuthal condensing apparatus.

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62. RONA.—No. 100.

Steamed for Rona; landed outside the island and walked up the rocks. There is a reflecting revolving light situated at the north end of Rona. The house and the dwelling houses near to each other, and provided with the same conveniences, instruments, &c. as the other lighthouses of the Commissioners of Northern lights. The reflectors have been altered so as to economise the light. The small end of the parabolic reflectors has been cut off, and a hemispherical reflector substituted; a small lens is placed so as to intercept the rays which would otherwise diverge past the edge of the reflectors. The result is said to be a very considerable improvement in the intensity

Holophotal apparatus

of the light. The keeper intends some night to take out a couple of the lenses and watch the revolutions from a neighbouring hill so as to judge of the difference, he was requested to communicate the result of his experiment to the secretary. The reflectors in this lighthouse were particularly bright and well polished. Both keepers are married, one has ten children, the other two. One is from Caithness, the other a native of Skye.

63. STORNOWAY.—No. 105.

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Steamed round the north end for Stornoway. Stopped opposite to the harbour lighthouse, and examined the "apparent light" on the rock at the entrance to the harbour. The light itself is revolving catadioptric, holophotal, on the same principle as Rona, but with fewer reflectors. There are two keepers. The house is of iron, lined with wood, all but the upper part below the lantern, which is *not* lined, and consequently is very cold in winter. The reflectors were beautifully kept, and the brasswork everywhere as clean as it could be made. The keeper was observed to interpose the sleeve of his jacket between his hand and the brass handle of the box in which the revolving machinery is placed. In all other respects the house was furnished, and fitted like the others, and in equally good order. The peculiarity of this light is the "apparent light," which consists of a holophotal catadioptric single lamp placed in a window at the foot of the tower as to project a powerful beam on a mirror placed on the top of a beacon in the sea. The light is reflected to seawards, and dispersed by a lens placed in front of the mirror, so as to give the effect of a light burning on the beacon. The deception is so perfect that the fishermen will not believe that there is not a light there.

The pilot on board has often seen it, but thinks it is hardly powerful enough, though very useful.

People on shore at Stornoway stated that it was very useful. The reflector behind the light is made of zinc, and the keepers said that it was impossible to keep it as bright as silver. It was dark, and an attempt to rub it brighter failed entirely. It is not stated in Mr. Stevenson's account of the light why the reflector is made of zinc. It appears to be inferior to silver, but it is probably less expensive. The keepers were dressed in their uniforms; one was formerly a veterinary surgeon, the other a joiner. Both married. Both with considerable families. After leaving, steamed out for Orkney, observed the lights at the entrance, both were very brilliant; made a turn to try to pick up the beacon light, but failed to see it. There was some light still in the sky, but the reflected light cannot have much power.

This light was subsequently observed by the secretary on a very dark night from the steamer, leaving Stornoway. It was visible at a distance of perhaps half a mile, but the light was feeble; it seemed about equal to a single candle. There is a considerable divergence in the beam thrown by the lower reflector, for the light was seen for a considerable distance on both sides of the beacon in passing outside of it. The arrangement might therefore be improved considerably, but the principle is established. The beacon is illuminated by a lamp on shore, at a considerable distance, and the apparent light was actually seen at a distance sufficient to enable vessels to clear the danger.

Observed the Cape Wrath light at 30 miles. The red and the white flashes were brilliantly visible and easily distinguished from each other. The night was very clear. The land of the Cape seen in the evening on entering Stornoway.

July 24th, Sunday at

Red light.

64, 65. STORMNESS.—No. 114, 115.

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25th, 3.30 A.M., landed at the large lighthouse. It is of uncoloured stone. There is a smaller lighthouse

*Holophotal
apparatus,
peculiar form.*

to the westward, and both are intended to open Hoy Sound. The larger lighthouse resembles that on Ardnarehan, and is a beautiful building. The illuminating apparatus consists of three fixed reflectors; one "holophotal" as large as a small herring barrel, with a red glass in front showing in one direction; the other, a reflector of ordinary size, showing in the other direction; the third, a section of a lens, with a section of a reflector behind it, showing towards the harbour of Stromness, and across the channel. There is no lightning conductor at this house. There are no fog signals. The keeper stated that he had never seen vessels near the lighthouse when fog cleared away. There are the usual books and instruments, and fittings, all in good order. The head keeper's name is Peter Ure. He is married and has one child. The assistant is unmarried. The principal has been at Cape Wrath, Lismore, and Calf of Man. He stated that the red light at Cape Wrath, is produced by ordinary reflectors and red glasses. Steamed through Hoy Sound, passed the Pentland Skerries; it was considered too rough to attempt a landing. Sighted Kinnaid lighthouse. Steamed for Buchan Ness, and landed at 1.20 P.M.

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67. BUCHAN NESS.—No. 124.

The house is situated on a promontory, and surrounded by a plot of ground belonging to the Commissioners. The light has been much praised by witnesses. The apparatus consists of 24 reflectors, fixed, three on a face. There is nothing peculiar in their construction. They were extremely well polished, and had not a scratch. The keepers' names are Alexander Wallace, married, two children; James Tennant, married, five children. The principal has served at the Bell Rock, Inchkeith, Cape Wrath, Start Point. There are no fog signals. The keeper had never seen vessels near in a fog. He has heard the steam whistles of passing steamers. There were the usual fittings, instruments, and books, all in order and well kept. The dwelling houses were also extremely neat, but it was thought that the colour of the building was objectionable. The birds killed here are starlings and blackbirds.

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68. GIRDLE NESS.—No. 125.

Steamed for Aberdeen, and landed at Girdleness. This has two lights in one tower. The lower light consists of 13 lamps and reflectors, fixed in a gallery round the outside of the tower, about half way up. Each cleaning powder has a separate box, beautifully cleaned, with the name of the material marked outside. There is the usual box for holding chimnies. The reflectors were in excellent order. The upper is a lens light, first order, with a mechanical lamp, and four wicks. A portion of the light is lost, for want of a reflector on the landward side. The machinery of the mechanical lamp appeared to be slightly out of order, it worked with a jerk. There are four keepers to this light. They are lodged in houses originally intended for two. Three of the keepers are married, one unmarried, one has four children. They are obliged to make up a shelf for two of them in a box bed, where they sleep above others, and must suffer for want of air. There are no fog signals here. In all other respects the house is fitted and furnished like the rest, and is in very good order. The keepers had not their uniforms and did not hoist their flag as others have done. It was remarked that the colour of this lighthouse is not clearly distinguished against the land.

*Colour of
building.*

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2 lights seen.

Oral evidence.

Ran to Aberdeen to coal. Admiral Hamilton and Mr. Gladstone landed and proceeded by rail to Edinburgh.

Landed, and examined sundry witnesses.

The manager of the London and Aberdeen Steam Company states that he had been manager for eight years. He had never heard a complaint of the lights

and had never known anything wrong with them during that time. *Cruise of the Vivid*

Mr. Kellasy of the Local Marine Board, has distributed 16 mariners' questions amongst the persons who were considered best able to give information on lights.

Mr. Rose, a large shipowner, has never heard any complaint.

Mr. Campbell, master of a London steamer, has sent in a return. He thinks that a light is wanted on Thieves Holme, off Kirkwall, a masking on the lights at Kinnaid Head and Buchan Ness, to indicate the approach to Rattray shoal, and one at the East Neuk of Fife.

The Harbour Commissioners had not begun to fill up the returns sent in by the Lighthouse Commissioners. They consist of 12 members elected annually by householders and shipowners, and 19 who compose the town council, and one ex officio Harbour Commissioner. The two leading lights under their charge are red when the harbour can be entered with safety, green when it is dangerous. Formerly the lights were extinguished when the harbour was dangerous. Both these arrangements were sanctioned by the Commissioners of Northern Lighthouses, and the Harbour Commissioners do not consider themselves responsible. The former arrangement was much complained of. The latter is approved of by the persons most interested, but there seems to be no good reason for departing from the rule that red indicates danger.

Mr. Reid, the Treasurer, has not heard any complaints of lights. There are some complaints of Rattray shoal.

69, 70. ABERDEEN.

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(Dr. Gladstone revisited these lights. See Aberdeen.)

Visited the two leading lights. They are of iron, with one light and reflector in each. The colour is produced by coloured glass placed in front of the reflectors. The signal for changing the colours is given from the end of the pier by showing a light.

There are no boxes for keeping the cleaning materials separate. All are consequently stowed away together in small wooden presses. The light-keeper is paralytic; his son looks after the lights. He was never taught to clean the reflectors. He has never been sent to Girdleness (within a mile) to see how they are cleaned there. He was a carpenter, and the reflectors under his charge and everything about the place was in a condition far inferior to the lighthouse under the Northern Lighthouse Commissioners. (No returns have been furnished, they have been repeatedly asked for.) Embarked, and steamed for Bell Rock.

71. BELL ROCK.—No. 126.

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On sighting the lighthouse, the day being grey, and hazy, the lower part of the house, which is dark, and the lantern, which was in shadow, were much more easily seen than the central part of the building, which is coloured white, and could hardly be seen at all against the sky. *Colour of building.*

Observed a large boat leaving the lighthouse.

The rocks about the house were showing above water. There are iron ways for landing. The keeper stated that the sea rises 13 feet up the base of the house. There is an excellent gun-metal ladder fixed. The four keepers are married, and have six, seven, three, and four children respectively. The head keeper is John Sinclair. The first story is for coals, the second for water, the next for oil, the next for bed rooms, lighted as at Skerry Mhore, with berths for six persons. The next room is the kitchen, above that the sitting room, in which is a marble bust of Stevenson, the engineer, placed there by the Commissioners, with a marble slab, on which their Minute is engraved.

The light is revolving, five reflectors on each of two faces, two red and two white. The red colour is produced by chimnies of red glass, which appear to

Red light.

*Cruise of the
Vivid.*

be much more convenient and should be less expensive than the large covers of coloured glass used elsewhere. The lantern and all in it was in very good order. The reflectors well cleaned, and the books properly and neatly kept. The visitors' book contained the names of a large party who had visited the light that afternoon, and had dined there. The manner of the head keeper gave rise to some doubts of his being sober; a correspondence followed with the Commissioners of Northern Lighthouses, which ended in the man being continued in his post.

Birds.

There are very few birds killed here. Thrushes and blackbirds occasionally in winter. The keepers catch a few fish. It appeared that this house was not quite so clean as some of the other rock stations. Steamed in for

sion to rouse the keeper, as he had never known the lower light to go wrong since it was first exhibited.

July 27.—The mechanical lamp on the contrary requires careful watching and constant attention. The fishermen consider the lower light to be brighter than the upper when they are within its range. This may be accounted for by the inferior quality of the glass, the damaged condition of the mirrors, and the distribution of the light round the whole horizon. Perhaps also by the haze which frequently settles on the Isle of May.

Steamed into the Firth of Forth, passing the Bass rock, and anchored at 8:20 opposite to Granton pier.

The result of this day's observations is very much in favour of the lights of the Commissioners of Northern Lighthouses, as compared with the smaller authorities, and of the Dundee lights as compared with Aberdeen.

Admiral Hamilton and Mr. Gladstone visited the *Edinburgh.*

office of the Northern Commissioners, and in the evening went to the establishment of Messrs. Milne and Son, Milton House, Canongate, in company with Messrs. Thomas and David Stevenson. Here they saw a new holophotal light in action. It gave a very good light as seen from Salisbury Crags, the distinction of the white and red colours being perfect. Amongst other explanations given by Mr. D. Stevenson in reference to the machinery at Messrs. Milnes, he stated that small lanterns are now made of cast iron, but large lanterns of gun metal, which they prefer to wrought iron. The astragals are now made to cross one another diagonally. Although a silver reflector is doubtless the best, a comparative experiment made on Inchkeith with a silver, a zinc, and a brass reflector showed no great difference in the light reflected, except as to its colour. The Northern Commissioners employ a very dark red glass, not the ruby.

July 28th.—Among the pieces of information given by the Messrs. Stevenson in the course of conversation were the following:—Some samples of colza oil corrode brass work, but the pure substance does not. It is not known what is the corrosive ingredient. It is proposed to employ bricks in the erection of the Butt of Lewis Lighthouse; specimens of these bricks were exhibited, having a conchoidal fracture, and exceedingly hard. The mortar to be used is composed of sand, lime, and "mine dust," that is scalings of iron; gneiss is considered preferable to granite for building purposes, as it does not disintegrate when exposed to the air and seawater, as many granites gradually do. It is difficult to mask a catoptric light sharply, for obvious reasons, and this constitutes one of the advantages of the dioptric system. Slate roofs have been adopted for many of the recently built keepers houses at the instance of the Board of Trade, but they let in wet, and are greatly inferior to the leaden roofs, which the Northern Commissioners prefer.

29th.—Visited the Office of the Commissioners of Northern Lighthouses in Edinburgh, the Secretary and several of the members were absent on their annual tour of inspection; Mr. Urquhart, and the engineer of the Commissioners, Mr. Stevenson, and his brother were at the office. The papers in preparation for the Commission were shown, the most difficult and tedious are those relating to the income of the various lights. They will still take a considerable time to complete. After a long interview with the gentlemen of the Northern Lighthouse Office the Commissioners visited the establishment of Mr. Milne, and inspected a new revolving light, constructed by Mr. Milne from the designs of Mr. Stevenson, of glass, manufactured in Paris, for Newfoundland. The apparatus consists of 12 holophotes, arranged on four faces, four on each of two sides to show red, with red glass chimnies, two on the remainder to show white.

The holophotal arrangement consists of a hemispherical reflector, with a lens and reflecting prisms placed in front. The lamp slides down to be cleaned, and can never be wholly removed from its frame.

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72, 73, 74, 75. DUNDEE.

July 27.—Landed at Dundee. Met Mr. Walsh, formerly master of the Trinity House, who stated that the secretary was absent. It subsequently appeared that the secretary was unwell.

Oral evidence.

Captain John Speck, master of the pilots, said he had never had a complaint of anything. He had never heard of any irregularity in the Bell Rock Light. It is a very good one. He has had considerable experience of the east coast. He thinks that a light on the Carr Rock would be of advantage, several vessels have been on shore on it. He has often heard the bell on the Bell Rock.

There is no uniform system of tide signals at the Scotch ports.

Captain William Lee, commanding one of the London steamers, thinks something should be done to clear Rattray Briggs to the North, where he formerly traded.

Mr. James Simpson thinks the Carr rock wants a small light. Has no difficulty at the Cross sands. Thinks the harbour light very good.

William Beattie thinks there should be a small light on the Carr rock. There is often a haze on the Isle of May.

July 30.—Visited the lights under the charge of this local authority. See DUNDEE Local Authorities, Scotland.

Landed the master of the corporation, and steamed for the land

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76, 77. ISLE OF MAY.—No. 127.

Observed the beacon on the Carr rock. Landed at the Isle of May. There are two lights; the upper dioptric, first order, the second on that principle set up in Scotland. The lower and upper beams of light are directed by mirrors, which are much spoiled. The glass is very green. The house was built in 1816. There are three keepers, two of whom are married. They have large families, who are educated by their parents, and are occasionally sent ashore for a time.

They are very well lodged, and besides there is a large room and some bed rooms which have occasionally been occupied by gentlemen who had orders from the Commissioners of Northern Lights. The whole island is the property of the Commissioners. It was purchased, with the lighthouse thereon, for 60,000*l.* from the Duke of Portland.

There are the usual fittings, instruments, and books, all in good order.

The birds killed here are starlings, thrushes, blackbirds, woodcocks, and small land birds. No sea birds ever kill themselves. The water is indifferent. The lower light is arranged for clearing the Carr rock. It has one reflector. A room below is occupied by one keeper, who goes to bed. The keeper in the upper light observes the lower through a pane of glass on the landward side, and if he sees anything wrong he has a bellows whistle, by means of which he can rouse the other at a distance of about three hundred yards, by sounding a large whistle at the head of the bed. He stated that he never had occa-

Birds.

The reflectors lift out, but the glass remains fixed to the revolving frame. The whole rests on a series of rollers, and is moved by a small toothed wheel, working a large one on the circumference of the frame, which is larger than usual. By these arrangements Mr. Stevenson secures great steadiness of motion, and solidity. The quantity of oil consumed was stated to be considerably less than that burned in a large mechanical lamp.

A letter was written expressing the hope of the Commissioners that the man at the Bell Rock might not be punished, and praising the rest of the establishments inspected in Scotland.

Buoy store,
Granton.

The Commissioners inspected the storehouses at Granton. The superintendent of the buoy establishment stated that he had charge of the whole service. There are four depôts for buoys, namely, at Granton, Corran Ferry, Campbellton, and Cromarty.

As full particulars regarding this branch of the service will be furnished officially, it was not thought necessary to take notes of all that was said by this officer.

The establishment was in good order. The spare bnoys newly painted were ranged under cover. The oil for the lighthouses was stored in the casks in which it is sent to the different stations, instead of tins as used by the Trinity House. The oil is run out of the casks into stationary tins, and the empty casks are returned.

Admiral Hamilton and Mr. Gladstone called on the Lord Provost, as one of the most influential members of the Board of Commissioners of Northern Lights, and had a short conversation with him.

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78. GRANTON PIER.

The Commissioners inspected the light at Granton Pier Head. It is a reflecting light, with an ordinary parabolic reflector, and shows through a window of red glass. Embarked on board the "Vivid," and steamed to

79. LEITH PIER HEAD.

Tide signals.

Landed and inspected the lighthouse. There is a tide gage here, a line moved by a float shows to the keeper inside the depth of water at Leith Docks, and indicates the signal to be hoisted. The signals for day are flags and a ball. The flags are stiffened by wires so as to be visible in calms. At night the depth is indicated by coloured lights produced by sliding small panes of red and green glass in front of a gas burner, and behind a small bull's-eye lens, near the foot of the tower. The light is under the Leith Harbour Commissioners. The keeper is furnished with a clock, a barometer, thermometer, and speaking trumpet, all in good order. He keeps a register, also in good order. The upper light is a small holophotal, made in Paris, on the principle of Mr. Stevenson. The light is gas, which occasionally goes out, and varies in intensity with the pressure on shore, as the shop lights, &c. are turned on and off. (This is one of the objections stated by Mr. Stevenson to the use of gas in lighthouses.) The reflector is of zinc, inferior to silver, but cheaper and sufficient for this position. The ventilation is said to be deficient. The glass inside "fogs" easily, that is to say it condenses the moisture produced by the combustion of the gas, which is not carried away with sufficient quickness. There is a spare oil lamp in case anything should go wrong with the gas, so as to render it useless. The metal fittings of the lens are bright. The engineer of the Northern Lighthouse Commissioners stated yesterday that the practise of scouring the backs of the reflectors and metal fittings of lenses has been abandoned, as it increases the risk of injury to the optical portion of the apparatus, without adding to its efficiency.

There are two keepers at Leith Light, one always in attendance. The establishment was in an efficient condition, and very neatly kept.

80. INCH KEITH.—No. 128.

*Cruise of the
Vivid.*
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Landed at Inch Keith. This is built on the top of the island. The building is a very handsome one, and the dwelling houses very comfortable and very neatly kept. There is a room called the visiting officers room, very neatly furnished, and reserved for the use of the officers of the Commission. The island is the property of the Duke of Buccleuch. The head keeper, formerly a sailor, has been at various stations, including the Bell Rock. The assistant and principal are both married. The light is furnished with the usual instruments, fittings, means of communication from the light room, &c. (It was explained by the engineer that the whistles were provided to obviate any necessity for leaving the lantern while the light is burning. Every keeper is bound to remain constantly at his post in the lantern during his watch.) The light is revolving, of "built" lenses on a revolving frame, and a set of stationary mirrors above, none below. The mirrors are much damaged, and the whole apparatus, like that at the Isle of Man, is old and inferior to the more modern lights. (The engineer stated that the Commissioners had often thought of renewing the apparatus at these lights, but they were restrained by the anticipation of objections to the expense). There is an experimental lantern close to the lighthouse, visible from Edinburgh. Some experiments are to be tried with red glass shortly, meantime there is nothing in the lantern.

Steamed past the Bass Rock and St. Abb's Head, failed to observe any indications of the new lighthouse in the latter place.

81. BERWICK.

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Observed the light at Berwick Pier Head. See Berwick local authorities, Scotland, for the observations on this light, which was much approved, and to which Mr. Stevenson specially directed the attention of the Commissioners.

July 30th. Anchored for some hours at Berwick. Observed the Longstone Light; was informed that the Fern Island was hardly ever seen, distant 16 miles.

82. FERN ISLAND.—No. 1.

ENGLAND.
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Landed at the Fern Island Lights at half-past five a.m. There are two lights in separate buildings coloured white. The larger building has 7 reflectors, ordinary parabolic. They were very well cleaned, but show only one on each face. The outer light on the Longstone has three on each face. It seems then that one parabolic reflector very well cleaned can very rarely be seen at Berwick, distant 16 miles, but that three can generally be seen. This was the case when observed last night, the weather being clear and the night dark. The cleaning boxes and all within the keeper's department were in good condition, but the revolving machinery was out of order, and was generally of inferior workmanship to the lights lately seen. The Elder Brethren visited the light on the 29th, and left orders for a man from London to visit the light and repair the machinery. The keeper is provided with a thermometer and a telescope, he has a medicine chest, and there is a lightning conductor. But there was no rain gauge; no fog signal; no blow tubes communicating with the lantern. The books kept are an order book and a register. The other books kept at a Scotch lighthouse are not kept here. One difference then in the services is that in the Scotch Service, every lighthouse is provided with the same instruments and fittings, and comforts and conveniences. That the English lights are variously provided in various situations, and are rarely furnished with many articles, always provided in the Scotch lights, such as the call whistle. That the Irish lighthouses visited are not provided with meteorological instruments or medicine chests, or lightning conductors, or libraries, or call whistles, or printed

IRISH, SCOTCH,
and ENGLISH
Light Establish-
ments compared.

Cruise of the Vivid.

framed regulations, or uniforms for the men, or clocks, or dials, or with any thing not absolutely required for keeping the light burning and the apparatus clean.

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83. FERN LOWER LIGHT.—No. 2.

The lower light has one reflector, and shows to the northward. The two lights in one indicate a passage, but they must show almost directly over a large rock in the middle of it.

There are three keepers. The one on watch attends to both lights, and has to walk a considerable distance from house to house during the night. At Inch Keith, where there is a similar arrangement, one of the three keepers sleeps in the lower lighthouse, which the keeper on duty in the upper light observes from the lantern; if anything goes wrong he can at once rouse the sleeping keeper without leaving his own post by working a hand bellows attached to a tube, which blows on and rings a bell at his ear.

Birds.

The birds killed at Fern Island are blackbirds, thrushes, and ducks, &c. not many.

The island is columnar basalt. There are many rabbits on it. There is an old chapel restored, and a ruin converted into a dwelling, where clergymen from Durham occasionally reside for short periods. Ran out to the

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84. LONGSTONE.—No. 3.

Colour of building.

The tower is painted red. Landed with some difficulty in consequence of the strong tide, which the boat could hardly make way against. The head keeper is William Darling, whose story is so well known. The assistant is his son. They complained of the smoke in the lower dwelling house. The apparatus is revolving, 12 parabolic reflectors showing three on each of four faces. All were in excellent condition, though old and getting worn out. The exterior of the lantern is cleaned by mounting moveable wooden steps, which rest on the external gallery. In all the Scotch lighthouses there is a fixed metal stair up to a light metal gallery, which runs all round, and handles to hold on by while cleaning the glass. The metal steps extend to the highest point in the roof. This arrangement is certainly preferable, though the moveable wooden ladder is less expensive.

Grace Darling.

The whole of this establishment is in excellent order, clean and neat, filled with memorials of Grace Darling. The father explained what had occurred on the occasion of the wreck of the *Forfarshire*, and pointed out the localities from the tower. He said that his daughter had died of a decline, and that in his opinion her end had been accelerated by anxiety of mind, which he explained by saying that so many ladies and gentlemen came to see her, that she got no rest. Steamed to

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85. COQUET ISLAND.—No. 4.

Colour of building.

The building is a square tower coloured white, with castellated dwelling houses about it similarly coloured. (The Scotch lighthouses are nearly all left of the natural colour of the stone of which they are built, and in many cases it is exceedingly difficult to make out the building against the land. Here were three lighthouses close to each other variously coloured. Red on the outer rock where the building must be seen against the sea or sky, and white where it is to be seen against the land. In this the Scotch system appears to be somewhat faulty.) The building is very handsome and very convenient, beautifully clean and neatly kept. The head keeper is Darling, brother of the renowned Grace. The optical apparatus is one half of a first-rate dioptric light on the Fresnel system. A narrow strip of red glass on either side shews proximity to two rocks to the north and south. A dark patch on the glass masks the light from the dangers, and at the back a light shews into the road-

stead from the lamp alone. This arrangement is very simple, and gives satisfaction; it illustrates the advantage of using lens lights for such situations as explained by Mr. Stevenson in his conversation with the Commissioners on this subject at Edinburgh. There is no arrangement of reflectors by which this variation in character could be so easily and so effectively given, and nothing could more clearly demonstrate the evil that must result from the position of the bar on the window at Berwick Pier light, which acts precisely as the screen acts here.

Ran into the Tyne and up to Newcastle. Called at the Office of the Trinity Board, saw the secretary and ran out again. Found that the tide was falling fast, so ran for Sunderland, and got into dock just in time.

July 31.—Sunday. Remained in dock.

Up to this point the Commissioners have inspected or have seen 85 light establishments. Many of the lights inspected were also seen alight.

August 1.—The Commissioners landed at Sunderland. The *Vivid* with the secretary on board started at 10 a.m., and anchored at 8.30 p.m. at Hull.

Captain Allen being anxious to get in before dark, none of the lighthouses passed were visited. Blowing hard and a considerable sea on at Flamborough Head.

August 2.—Examined pilot master at Hull.

He said the lights in the Humber are good, and did not wish for any change. Orfordness, Cromer, and Winterton are bad to see in fogs. I never could mistake the floating lights for ships' lights. "Oh! no, I never knew such a thing to happen." The floating lights are very good in the Humber, dioptric and catoptric lights. I don't know much about them. The South Foreland new (electric) light is the best I ever saw. I saw it from Kentish Knock, about 40 miles. I could not then see the lower (catoptric light). I thought it was a star.

Examined Thomas Lewis, master of the *Vigilant*, at the hotel. He said all the lights on the east coast are good, Hazeborough is, perhaps, a little low. A light would be useful on the Cross Sand End. The river Humber is very well lighted and buoyed. They are as good as can be, I never heard a complaint. It is all good all the way to London.

"Buoys would be of no use on the way to Goole. The sands alter every spring tide."

Messrs. Krüger and W. G. Martlett, commanders of steamers in the merchant service, bore unqualified testimony as to the equality of the British lights with those of any foreign country. The former mentioned those in the Gulf of Finland, and the latter, that at Dunkirk as equal to the English. Mr. Krüger had frequently observed the revolving light on Flamborough Head at a considerable distance when the red flashes are not seen, but the light presents the appearance of two white flashes separated by rather a long interval from two similar flashes. The Humber is well buoyed and lighted but a light on the Haile would be valuable. Some of the Commissioners then visited the enclosed dock and inspected the Spare Light ship. The rest questioned several other captains and pilots. For remarks on the Humber Lights see HULL.

Red light.

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93, 94. SPURN.—Nos. 9, 10.

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August 3.—At 7 a.m. landed at Spurn. The larger tower is of brick, coloured red, enclosed within a circular wall, which also encloses the dwellings, and a paved court with small gardens. The smaller tower is coloured white, and stands within high water mark on a foundation of piles and concrete. Both are situated on a long spit of land with bent growing on it, and to seaward there is a chalk wall with piles to keep off the encroachment of the sea. Everything about this establishment, which is under the Trinity House of London, is in excellent condition. The houses are large, roomy, well found, and very neatly kept. The lighthouses scrupulously clean, and every

Colour of building.

Catoptric and Dioptric apparatus compared.

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7 lights seen.

Oral evidence.

bit of metal, even the bars of the lantern, scoured bright. The usual meteorological instruments and registers are kept. There is a medicine chest; a lightning conductor; the upper light is dioptric, first order; the same lens that was shewn at the exhibition of 1851, fixed, with a fountain lamp. The lantern has the diagonal bars. The dome is white inside. The lantern is cleaned outside by mounting a moveable wooden ladder instead of the fixed stage and steps used in Scotland. There are no communicating tubes from the rooms or from the lighthouse as in Scotland. There are three keepers, and the one on watch has to walk from lighthouse to lighthouse during the night. The plan pursued at Inch Keith and elsewhere in Scotland appears better. There one keeper watches both lights, and can summon a keeper who sleeps in the distant lighthouse without moving from his own post in the larger lantern.

In these particulars this first-rate English establishment is inferior to the first-class Scotch stations. In other respects it would be difficult to find a better lighthouse better kept.

The lower light is a small dioptric light, 5th order, equally well kept. The house is joined to the sand by a wooden stage. On leaving these lights observed the red and white towers with the photometer, both showing against a cloudless sky a slight purple haze on the horizon, and the sun shining brightly from a point behind the observer, and not far from the horizon. The sky behind the red tower was lost, and that tower became invisible at 2-10. The white tower and the chalk wall at the edge of the sea were lost at 2-30. The white was, therefore, more clearly seen, because there was then more light reflected from it than from the sky beyond it. Boarded the

more than the apparatus hoisted by the lightships. It could be swung on gimbles, and it might be lowered down a hollow mast like the funnel of a steamer. Salt water would not act on the glass, and unless broken to pieces the lens would be much less liable to injury than the reflectors which seem to be more or less injured on board of all the lightvessels, and which, according to Mr. Wilkins, the manufacturer, wear out much sooner afloat than on shore.

The master stated that his vessel rides very easily, "she has the full long sea from the German Ocean." It seems then that the more exposed the station the easier it is for riding in, provided the water be deep. The master from the Hebbles far up the Humber, found a worse sea than he had ever found in his 60 voyages across the Atlantic. The master at the Bull complained more than the master at the Spurn, and the master at the Owers complained more of his station than did the master at the Seven Stones, who said that his vessel rode easily over the long seas of the Atlantic. The master at the Blackwater made a similar statement. Steamed for

Cruise of the Vivid.

Wate.

See Hull: Vol. II. 317.

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96. CROMER.—No. 12.

Landed, and walked up to the lighthouse, on a high promontory. The old lighthouse is still standing close to the edge of the cliff. It was abandoned because it was feared that the cliff would fall. The new tower is built some distance inland, it is painted white and has comfortable dwellings attached.

The light is revolving, ten reflectors on each of the three sides. There are the long tubes from above the lamps to carry off the smoke and other products of combustion. The dome is white inside. The reflectors were in good order, and the whole establishment clean and neat except where the painters were at work.

The Hazeburgh light, and the Leman and Ower floating light, are seen from here, distant about 12 miles. In heavy weather, the keeper remarks, that the floating light dips, and occasionally disappears when the vessel rolls in the sea. The revolving machinery went out of order some years ago by the breaking of the rope. The keeper kept the lamps moving by hand till the rope was mended. The reflectors are wearing out, some are 37 years old, and are better than those which are 27. The copper is showing here and there through the silver.

The glass chimneys break according to the weather, sometimes three or four dozen a month. They vary in size very much, some have to be returned as useless. The reflectors are moved from their frame when cleaned. This was considered objectionable by Mr. Stevenson, who thinks that reflectors should, if possible, never be moved from their frames to avoid any change in their position. There is a lightning conductor, and the usual books (Trinity House), and instruments all in good order. There is no medicine chest, as the light is so near the town of Cromer. The agent resides at Cromer, and has charge of one lighthouse. There are two keepers, both married. The head keeper was formerly a carpenter, he has been 22 years in the service. His grandfather used to keep a coal light at this station, and used to consider it very hard work. The outside of the lantern is cleaned by ascending a moveable ladder. The sand blows up, and that circumstance may in some measure account for sundry scratches on the reflector. Sighted HAZEBOROUGH, two towers, both white.

97. COCKLE.—No. 7.

Boarded the Cockle Lightship. She is of wood, painted red, shorter than the Irish light vessels, and sloping outward, flames above. No witnesses out of the first 500, have mentioned that this vessel has been adrift. The master stated that she had been twice adrift, in 1849 and November 1856 as nearly as he can remember. There was a very heavy gale from

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95. SPURN FLOATING LIGHT.—No. 1.

The master has been thirty years on this station which is within a few miles of the Spurn lighthouses. He stated that in hazy or dark weather he can often see the red lighthouse when he cannot make out the white one at all. It seems that white is best seen in bright sunny weather, even against the sky, but that dark colours are best seen against the sky in dark or hazy weather.

The master also stated that the light on Spurn Point had been very much improved by the change (from catoptric to dioptric), though he was quite ignorant of the nature of the change, having never visited the lighthouse. He stated that the small light did not show very well which he attributed to its proximity to the large and very powerful light beside it. The light-vessel also belongs to the London Trinity House. The crew were mostly below and were taken by surprise, but the vessel was scrupulously clean. The light is revolving. There are four reflectors, which with the lamp are hung upon gimbles. They were very well cleaned and had fewer scratches than are usually found on the reflectors of floating lights. The lamplighter explained that scratches are often produced by portions of the charred wick falling on the silver. These, as he expressed it, cut like a knife, and unless removed with great care, injure the reflector. He did not think that sand could get at them at sea; he thought that salt water might, and might produce some injury. It was observed that the machinery for the revolving light worked very loosely, the cogs worked nearly out of gear by the motion of the vessel. Remarking on this, the master stated that the Elder Brethren, on their late visit had noticed the same, but a great difficulty occurs in rectifying this, for on tightening the cogs the machine, from its small power, would fail to work and interfere with the regular revolving of the light.

It seems to be well worth consideration whether small dioptric apparatus could not be substituted for catoptric on board vessels, such a lamp as is used at the Lower Spurn Land Light would hardly weigh

Call whistles.

Colour of building.

Experiment with photometer.

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Colour of building. Evidence.

Catoptric and Dioptric systems. Evidence.

Dioptric apparatus afloat.

- Cruise of the Vivid.*
Lightvessel adrift.
the N.N.W. on both occasions, and the vessel was brought up almost immediately with his spare anchor. She would otherwise have been lost on the sands. In similar weather and lee tide, the master and one man always remain on deck with axes handy, to cut the spare anchor adrift. On both the occasions the chain broke on deck.
- Model of vessel.*
The master thinks the vessel would ride easier if she were longer. This light is revolving, she has four reflectors which were in such good order that the lamplighter was requested to show his process of cleaning them; he first put on a canvas apron, he then selected from a particular box a clean white cloth with which he wiped the inside of the reflector, which he held against his breast carefully avoiding to touch the silver with his hand. He next dusted some rouge over the silver from a linen bag, which acted as a kind of sieve, and the cleaning was finished with a leather taken from another box used for that purpose only. There was nothing peculiar in the process, and the man could see no reason why reflectors should be more scratched at sea than on land. Everything on board this vessel, especially the place set apart for cleaning the reflectors, was scrupulously clean. The decks as white as those of a man-of-war. Many vessels run foul of the Cockle, one did last May. The master is a Yarmouth man. He says he often foresees a gale by noticing the sea coming in before the gale begins. This was stated by the keepers of the Irish light vessels, where barometers are not provided. This ship had the usual instruments, books, &c., all kept in good order.
- Cleaning reflectors.*
Ran in to Lowestoft, landed pilot and took in another for Yarmouth at 8 p.m., observed Stamford Lightship, LOWESTOFT High Light, LOWESTOFT Low Light, and two PIER LIGHTS. All in sight at the same time and all burning brightly.
- 4 lights seen.
- Vol. II. 73. 112. PAKEFIELD.—Nos. 18.
- Observed Pakefield red Light at 8.20 p.m. bright, it opened at the point indicated by the chart, and guided the vessel through a narrow passage. Shortly afterwards observed the lights on
- Vol. II. 74. 113, 114. ORFORDNESS.—Nos. 19, 20.
- right a-head. The low light was decidedly much brighter than the high light. The pilot on board said, "We always see the low light first." One of these is dioptric and the other catoptric. The pilot was unable to give any information as to which was the lens light, and stated that the difference between them was that one was to the eastward of the other. Stopped opposite the lights and endeavoured to test them with the photometer, but failed to get any reliable measurement, as the high light appeared to change in intensity as the vessel drifted.
- Catoptric and Dioptric apparatus compared.*
Steamed for Harwich and watched the Orfordness lights till the lower was lost beneath the horizon or behind the land, at about 13 miles at that distance, off Harwich; both lights were very bright seen from the bridge, and the difference between them was much less marked than from the northward. The low light appeared to be whiter than the other, and was seen through a greater thickness of the photometer all along. Both these lights are excellent. The low light is clearly the best as seen from the north, and slightly the best as seen from the south at a distance of 13 miles and under. From the point where the Orfordness lights were last seen, eight lights were visible at once, each showing some particular channel, all burning brightly and easily distinguished from each other. These were the SUNN WASH and CONK vessels, the GUNFLEET revolving red, the distinctness of this light was very remarkable, showing at that range a brilliant red, the two ORFORDNESS lights, and three HARWICH HARBOUR LIGHTS.
- The changes of colour and position in these last, as the vessel ran into the harbour guided by them were remarkably rapid and distinct, a fourth light appeared on entering the harbour, which changed with equal rapidity from white to red, and to white again as the vessel passed the shoal which it indicated. (*From the returns it appears that the lower Orfordness light is the dioptric.*)
- 115, 116, 117, 118. HARWICH.—Nos. 21, 22, 23. Vol. II. 75, 76.
- August 4.—Landed to inspect the harbour lights. Mr. Vaux, a shipowner and builder, stated that the spit at the mouth of the harbour has extended so far as to make the present position of the lights somewhat objectionable. The lights have not been changed for nine years, and the spit has altered considerably. The two lights in one, formerly led clear of the spit, they now lead directly over it, and the rapid changes of colour observed last night are intended to guide vessels clear of the danger. He thinks that the position of the lights should be changed. The keeper subsequently stated that several plans had been talked of, one to remove the lights to another position altogether, another to make the outer light a moveable one on wheels, a third to construct a beacon on the spit and to illuminate it with an "apparent light." This last proposal originated in the town, the others were the schemes of the Trinity House who have charge of the lights. Inspected the HARWICH HIGH LIGHT. It is in a white tower with comfortable dwellings attached and within it. There are two lights in the tower. The lower consists of a single Argand burner with a section of a large lens showing through a narrow opening towards the spit end. One strip of this lens is left clear and shows the passage, the rest is coloured red by a strip of glass, and shows the approach to the spit. When a vessel is inside the spit, another light on the opposite side of the harbour appears and leads in. A portion of the light of a lamp is deflected by a section of a silvered reflector and shows through a window when vessels reach a particular part of the harbour. By this arrangement a portion of the light is lost, but from observation enough is used.
- The upper light has nine lamps and reflectors set in a hollow curve as at Lynas, near Liverpool. The lamps have long chimneys to the ventilator. Some of these are forty years old. They are in very good condition and very well kept. Some marks were attributed either to old hammer marks nearly worn out, or to the points of glass from broken chimneys falling on the silver. The keeper stated that he could mark the silver with his nail. This remark shows the extreme care required to preserve reflectors in their present state of efficiency.
- There are three keepers, all married. The head keeper is 74 years of age, and was attached to the light when it belonged to General Rebow. He remembers the burning of coal fires at this station when he was a boy. The coals were burned in a grate, to which a pair of bellows were attached. The light-keeper was exposed to all weathers, and had to poke the fire, throw on coal, and blow the bellows when necessary all in the open air. Observations are now taken and a register kept of the Gunfleet and Cork lightvessels through three glasses similar to those used at some of the lighthouses on the West Coast of England. The keeper stated that he could occasionally see the lights through more than three glasses, but that the Gunfleet had been invisible from fogs for three weeks at a time.
- HARWICH LOW LIGHT, at a short distance from the other tower and nearer the sea, has three reflectors outside a curve. The lamps have the usual long chimnies, and in addition an apparatus for condensing the water produced by the combustion. The ventilation in these lighthouses is well attended to, and there are the usual books and instruments kept. The whole establishment is exceedingly well kept, the reflectors especially. The keeper could give no reason why reflectors at sea should be more scratched than on land. One keeper watches all night in the high
- Coal fires as coast lights.*

tower. The other two watch half the night each at the lower tower. The Isle of May arrangement would enable one to do all.

Inspected buoy establishment. It was in good order. At quarter past six p.m. passed close to the Cork light vessel. The crew neatly dressed were mustered on the deck.

Boarded the

Vol. II. 77. 119. GUNFLEET PILE LIGHT.—No. 25.

This had been previously seen from a distance, burning well. The illuminating apparatus was now found in very good order. It consists of nine reflectors with a red glass placed in front of each, fixed on a triangular frame, and revolving. On leaving the light it was observed that the red was visible all round. This gives a good measure for the divergence and loss of light inseparable from the use of parabolic reflectors, and shows the value of the lens used in some Scotch lighthouses.

The establishment was in process of painting. There is a fog bell, and the usual instruments are kept. The keeper stated that the sea never reached the lantern, not even spray in any quantity. On leaving the Gunfleet, observed the

Vol. II. 115. 120. SUNK LIGHT.—No. 11.

Saw Harwich light and passed the Gunfleet. Passed close to the

121. MIDDLE SWIN.—No. 15.

Revolving light, burning brightly, and anchored for the night.

Vol. II. 77. August 5th.—Sighted 122. The Maplin pile light, similar in its construction to the Gunfleet, No. 25. Boarded the

Vol. I. 117. 123. MOUSE.—No. 16.

Found all hands below except the look out. Every thing on board the vessel was in first rate order, clean and neat. The reflectors were quite equal to any that have been seen afloat. The gimbles worked well and easily. The lamp room arranged on the same plan as all the other lamp rooms on board Trinity floating lights, remarkably clean, and the leathers, &c. all in their proper places. Books in order; usual instruments kept. The master stated that he had once been adrift, wind N.N.W.

Passed 124, 125, 126. GIRDLER, PRINCES Channel and TONGUE Lightvessels, No. 20, 19, 18, and steamed to Margate. Landed and drove to the

Cruise of the Violet,

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119.

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127. NORTH FORELAND.—No. 29.

The tower is in process of strengthening previous to the placing of a new and enlarged and a dioptric light. The present apparatus consists of 18 reflectors placed on the outside of a curve in two rows, each lamp and reflector having a separate iron pillar as a stand. This arrangement is different from any yet seen. The reflectors are in excellent order, and apparently very old. There were marks of old injuries nearly obliterated by careful cleaning. Each lamp has a long metal chimney leading to the ventilator in the top. There is a tube for condensing water, but never used. A coal fire was originally burned on this tower. It was then raised and the present apparatus placed on it. The interior of the tower was then used for a dwelling. The two keepers now occupy two neat dwellings at the foot of the tower, and when the new light is placed the tower is to remain empty. The keeper sees Grinsz and Calais on fine nights; he has seen Dunkerque once. On that night there was a severe thunderstorm, and the light appeared as three lights, one above the other. Grinsz and Calais had the same appearance. The keeper had observed the electric light while exhibited at the South Foreland; he was not favourably placed for seeing it. He said it was flickering. There is a sufficiency of evidence given by witnesses besides the personal observation of the Commission to prove that the light was far superior in brilliancy to any now exhibited on the coast. Embarked at RAMSGATE (see *Local Returns*), and rounded the GULL, No. 22. Observed the monster buoy on the Goodwin Sands riding upright and showing like a vessel. Rounded close to the stern of the GOODWIN, No. 21, light-vessel. She is of iron, painted red, with three masts, and apparently longer in proportion to her breadth than the other lightvessel of the Trinity House, and more like the Irish lightvessels.

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„ 305.

She was riding across both wind and tide which were against each other, to windward of her moorings. Steamed for Woolwich.

The Commission had now been afloat 32 days, had almost circumnavigated Great Britain, had seen, so as to be able to form an opinion of their efficiency, 130 light establishments, of which 79 were personally inspected.

PERSONAL OBSERVATIONS

OF THE COMMISSION ON LIGHTHOUSES, &c.

IN FRANCE AND SPAIN.

Oct. 19th, 1859.—Admiral Hamilton, Mr. Graves, Mr. Gladstone, and the Secretary, travelled from London to Paris.

The captain of the steamer stated that in foggy weather he steams by the sound of a bell placed on Boulogne pier, and that the sound is quite sufficient to enable him to take the bearings and proceed under full steam. (*A report on this bell will be found at page 221.*) On arriving at Paris the Commission met Captain Ryder, who had visited the Channel Islands and the South of France, and who had inspected several small harbour lights. (*His account of his observations will be found at page 38.*) In crossing observed the buoy on the Varne, watching well and very efficiently. The captain states that he had seen a vessel aground on the Colbart Bank, which

has neither buoy nor beacen. (*A Floating light has been placed on the Varne since the loss of the Bervie Castle.*)

Oct. 20th, PARIS.—Admiral Hamilton, Mr. Gladstone, Mr. Graves, Captain Ryder, and the Secretary called at the office of the Conseil General des Ponts et Chaussées, and were directed to the house of Mons. Reynaud, Directeur General des Phares, 96, Rue St. Dominique, where they waited on Mons. Reynaud, who received the Commission very cordially, presented the chairman with a map of the lighthouses under his charge, and promised to forward the views of the Commission as much as possible. An appointment was made for 3 p.m., at the establishment of the Commission des Phares, Quais du Billy, No. 56. At the hour agreed on

France.

the Commission accordingly met Mons. Degrand and Mons. Reynaud, and were shown the Museum and other objects of interest.

The establishment consists of a lofty tower, placed on a rising ground facing the Champ de Mars, with a number of buildings and workshops, &c. attached. On the top of the tower is a lantern, from which experiments are tried. The position of the experimental lighthouse is so chosen as to command a clear range of 1, 2, 8, 12 miles, as may be desired.

Electric light.

The Commission were shown some experiments now making on the electric light.

The machine is a modification of that used by Mr. Holmes at the South Foreland. It consists of eight sets of horseshoe magnets placed on the circumference of a long wheel, of the diameter of about four feet, instead of two wheels of a diameter of about eight feet, as used at the South Foreland. The magnets pass close to iron discs in the core of the wheel, and induce currents, which are conveyed along wires to the carbon points where the light is produced. The wheel is turned by a small steam engine; but it might be made to revolve by any other sufficient mechanical power. One difference in the two machines is, that in this the currents are alternate; whereas, in Holmes's, they are made continuous by a complicated arrangement on the axis of the wheels, which reverses the poles.

It was stated that the alternation of the currents produced no sensible difference in the light, and none was observed by the Commission.

The light was exhibited in a large darkened room, and its intensity was remarkable.

Tested against an Argand lamp, it was found to be equal to 94 burners. With a square lens of cast glass, and Holme's charcoal points, it was estimated at 55,000; with the improved charcoal points, and a much larger ground glass, at 220,000; with a red glass interposed it was reduced to 1,030. (Mons. Degrand stated that the red, as compared with white, improved as the distance increased.) And it was stated that the best lens, with the most powerful oil lamp, was only estimated at from 80 to 90. The light varied considerably as the charcoal points wore away; it flickered, and occasionally went away altogether for an instant. This imperfection seemed to be caused by the charcoal; and if that could be remedied, either by the use of Professor Way's stream of mercury, or by any other means, the electric light produced by revolving magnets might be introduced into lighthouses.

The intensity of the light was tested by looking at shadows projected by it on a screen of whitened glass placed at a distance of about 20 yards, and by comparing these with shadows thrown by a lamp placed at a distance of a few feet, or a few inches, as the case might be. The figures given are the result of a calculation founded on the distances of the lights compared, from the glass screen, and cannot be taken as exact, though they express the difference roughly.

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These last appeared to have been very roughly handled, and it was stated that the keepers had never acquired the art of cleaning them properly.

There were spherical reflectors joined together on the same principle as the parabolic reflectors now used in the light ship at Liverpool.

In the centre of the room is a trophy of condemned lenses with mirrors, such as are now used at the Skerryvore and Luch Keith lighthouses in Scotland. Built up lenses, such as the first lenses were; and beside them were the lenses now used in the best French, English, Scotch, and Irish lighthouses. In addition to these, plates were shown of glass moulded into the

required angles in iron moulds. These are being introduced in French lights, and it was stated that their reduced cost would very greatly reduce the expense of illumination without diminishing the amount of light. What is lost in the inferior polish of the surfaces is said to be gained in the reduced thickness of glass.

Mons. Degrand considers that this improvement will be a great step in lighthouse illumination.

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There are no independent local authorities as in England, and the system must be uniform. It remains to be seen whether the system works well.

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October 21st, PARIS.—The Commission met Mons. Reynaud and Mons. Degrand at the establishment of Mons. Le Penaut, manufacturer of lighthouse apparatus. The lenses are ground in rings on wheels which revolve horizontally, and the required angle is obtained by arms which are fixed to the axle, and have certain cushions at the end, by means of which the prisms are reduced with sand. The final polish is given by hand with rouge. The glass was remarkable for its purity. The angles are all calculated to throw a parallel ray horizontally, and in the case of a light placed high, the pannels are slightly inclined so as to throw the rays downwards to the horizon. (On this point, see the Report on Messrs. Chance's Works, p. 43.)

Proceeded thence by rail to Argenteuil, and inspected the establishment of Mons. Joly, where there was a large bell buoy on the Herbert principle intended for the mouth of the Seine. The Secretary suggested a plan of ringing the bell, which was approved by the French engineers.

The buoy is large—5m. 80. above water line, and is to be surmounted by a ball and mirrors. It is provided with a fixed projection like a rudder to steady it and prevent it from turning.

In the course of conversation the engineers stated that the light produced in the French lighthouses was more than that produced in English lighthouses of the same order; because the consumption of oil *Measure of per hour was greater.* This conclusion can only be light, just if the oil is advantageously consumed. It was also stated that the flame of a lamp properly trimmed is larger and brighter than the flame of the same kind of lamp as used in the English lighthouses, according to the personal observation of Mons. Reynaud when in England. It was also stated that the light at Grisez is by no means one of the first excellence, though it has been repeatedly praised by English mariners in their evidence as one of the best French lighthouses. (See Abstract of Mariners' Evidence p. 110.) This may arise (according to Mons. Reynaud) from the comparison with the light on the opposite coast (Dungeness), which is not one of the best in England. The keepers are generally said to be old soldiers, who take a great interest and pride in their lighthouses. There is an intelligent officer, generally an engineer, within reach of almost every lighthouse in France, charged with a superintendence of the light, and the whole system is under one man residing in Paris, who is a member of a council (Ponts and Chaussées) which forms a department of the Government. In short, so far as the frame

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Oral Evidence.

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French buoyage.

Captain Baker, in sailing between Liverpool and English lights, and complains taken it for a variations of the light is catoptric, expected by the bars were very neighbourhood ful." Captain Baker on a frequent visit with an English light, his testimony is favourable to red lights, rather he has been at Pontillac, France, and that at (him), were not visible. Captain Baker has traded on the north coast of Spain, and thinks these lights equal to the French, and superior to the English. He also thinks that lights placed near high land are often obscured by the condensation of fogs near the land.

Boarded a French steamer, and questioned the mate. He thinks the English lights as good as the French; he trades to the north of Europe, and is well acquainted with the English lights; when the wind is in certain quarters his vessel, to use his own words, "souvent tombe cr-r-rack sur le galloppare."

October 26th.—Travelled by rail to Arcachon, a newly-built watering place on the basin; hired a boat with some difficulty, as the wind and tide were both contrary, and were pulled over by four Gascons to the lighthouse on

131. CAP FERRET.

The tower is white, and stands on a low promontory of land, which forms one side of the entrance to the basin. The channel is extremely narrow and intricate, and is not buoyed. The sea was breaking heavily on the sand banks, and on the Dunes outside.

The tower is white, a round column on a round base. The base contains the rooms of the keepers. The tower has no floors, and is ascended by a cork-

screw stair. The gallery round the top is broad, and the whole edifice is remarkably solid, and apparently well built.

The illuminating apparatus is lenticular, but the upper and lower portions consist of rows of mercurial mirrors, instead of glass prisms, six rows above and three below. These are damaged, as they are in Scotland and elsewhere, where they have been in use for a long time. They are considered by the lighthouse authorities in Paris as out of date, and are included amongst the curiosities in the museum. To the landward side is a large silvered spherical reflector, intended to reflect the light to seaward. A portion of the light is seen above and below the mirror from the basin, and is useful to fishermen and others. These reflectors were clean, but decidedly inferior to English reflectors of the same kind.

The lamp is a mechanical pumping lamp. The guardian explained that he had been carefully instructed in all that pertained to the machinery; that he had been required to take it to pieces, and set it up again, before he was intrusted with the care of the light.

He showed his manner of levelling the burner with spirit levels, and of adjusting the lamp in the focus of the lens, by means of a string attached to a point on the framework, but there was no contrivance for setting the lens or the lamp, so as to throw the light downwards to the horizon. It is manifest therefore that here, as elsewhere, a considerable portion of the light must be thrown upwards above the horizon and lost. If the lens were set to throw a horizontal beam, the light would pass above the horizon at the height of the lighthouse; but as the light is seen at a distance of a few miles, the beam must have a considerable divergence, and that must be as great upwards as downwards; consequently the greater part of the light is thrown on the clouds.

Instruction of keepers.

Direction of beam.



Lighthouse beam thrown at right angles to the axis.

The bars of the lantern are horizontal and vertical, instead of diagonal, as in Scotland; and, in that respect, inferior, for horizontal bars cast shadows and obscure the light. (See Report on Berwick.)

The lantern is surrounded by a network of strong wire, as the number of large wild fowl which fly against it is such as to endanger the strong glass. About 200 birds were so killed this year.

There are three keepers. No provision is made for lodging their families, but they have obtained permission and have built huts for themselves. One of these was also occupied by a party of sportsmen who had come for the purpose of shooting pigeons.

The register was inspected, and was found in order; made up to the last date. The keepers are required to consume a certain quantity of oil per hour, and the quantity consumed is taken as the measure of the light produced. The quantity is ascertained by sounding the oil in the reservoir, and estimating the weight consumed by a table provided for the purpose. (See Captain Ryder's remarks.)

There is a lightning conductor; no barometer; no thermometer. The keepers would be glad to have both, and to keep the register. There is no dial; they have often applied for one in vain. There is a clock. There are no means of communication between the lantern and the rooms below. The keeper on guard is allowed an arm chair, but no books. Arm chairs are forbidden in Great Britain, and books are provided.

Injury by birds

Measure of light.

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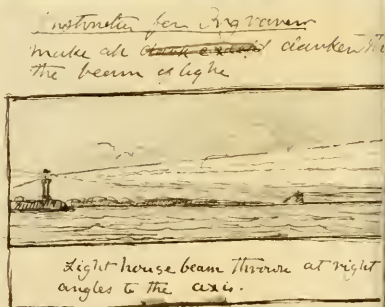
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ol. II. 90. He sees the LONGSHIPS, No. 52, and complains that it is very poor; he has mistaken it for a ship's light. On referring to observations of the Commission it appears that the light is catoptric, 20 reflectors, fixed, and when inspected by the Commission, July 8th, the reflectors were very bright. The boatmen in the neighbourhood stated that the light was "beautiful." Captain Baker's opinion is, therefore, formed on a frequent comparison of French dioptric lights with an English fixed catoptric in good order, and his testimony confirms the rest of the evidence, and is favourable to dioptric lights. With reference to red lights, Captain Baker says that in hazy weather he has seen the red flash of the lighthouse at Pontillac, when the white light at the same place, and that at Terre Nègre (a lighthouse nearer to him), were not visible. Captain Baker has traded on the north coast of Spain, and thinks these lights equal to the French, and superior to the English. He also thinks that lights placed near high land are often obscured by the condensation of fogs near the land.

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October 26th.—Travelled by rail to Arcachon, a newly-built watering place on the basin; hired a boat with some difficulty, as the wind and tide were both contrary, and were pulled over by four Gascons to the lighthouse on

screw stair. The gallery round the top is broad, and the whole edifice is remarkably solid, and apparently well built.

The illuminating apparatus is lenticular, but the upper and lower portions consist of rows of mercurial mirrors, instead of glass prisms, six rows above and three below. These are damaged, as they are in Scotland and elsewhere, where they have been in use for a long time. They are considered by the lighthouse authorities in Paris as out of date, and are included amongst the curiosities in the museum. To the landward side is a large silvered spherical reflector, intended to reflect the light to seaward. A portion of the light is seen above and below the mirror from the basin, and is useful to fishermen and others. These reflectors were clean, but decidedly inferior to English reflectors of the same kind.

The lamp is a mechanical pumping lamp. The *Instruction of keepers.* guardian explained that he had been carefully instructed in all that pertained to the machinery; that he had been required to take it to pieces, and set it up again, before he was intrusted with the care of the light. He showed his manner of levelling the burner with spirit levels, and of adjusting the lamp in the focus of the lens, by means of a string attached to a point on the framework, but there was no contrivance for setting the lens or the lamp, so as to throw the light downwards to the horizon. It is manifest therefore that here, as elsewhere, a considerable portion of the light must be thrown upwards above the horizon and lost. If the lens were set to throw a horizontal beam, the light would pass above the horizon at the height of the lighthouse; but as the light is seen at a distance of a few miles, the beam must have a considerable divergence, and that must be as great upwards as downwards; consequently the greater part of the light is thrown on the clouds. *Direction of beam.*



Lighthouse beam thrown at right angles to the axis.

The bars of the lantern are horizontal and vertical, instead of diagonal, as in Scotland; and, in that respect, inferior, for horizontal bars cast shadows and obscure the light. (*See Report on Bervick.*)

The lantern is surrounded by a network of strong wire, as the number of large wild fowl which fly against it is such as to endanger the strong glass. *Injury by birds.* About 200 birds were so killed this year.

There are three keepers. No provision is made for lodging their families, but they have obtained permission and have built huts for themselves. One of these was also occupied by a party of sportsmen who had come for the purpose of shooting pigeons.

The register was inspected, and was found in order; made up to the last date. The keepers are required to consume a certain quantity of oil per *Measure of hour, and the quantity consumed is taken as the measure of the light produced.* The quantity is ascertained by sounding the oil in the reservoir, and estimating the weight consumed by a table provided for the purpose. (*See Captain Ryder's remarks.*)

There is a lightning conductor; no barometer; no thermometer. The keepers would be glad to have both, and to keep the register. There is no dial; they have often applied for one in vain. There is a clock. There are no means of communication between the lantern and the rooms below. The keeper on guard is allowed an arm chair, but no books. Arm chairs are forbidden in Great Britain, and books are provided.

131. CAP FERRET.

The tower is white, and stands on a low promontory of land, which forms one side of the entrance to the basin. The channel is extremely narrow and intricate, and is not buoyed. The sea was breaking heavily on the sand banks, and on the Dunes outside.

The tower is white, a round column on a round base. The base contains the rooms of the keepers. The tower has no floors, and is ascended by a cork-

France and
Spain.

Sailed back to Arcachon, and slept at the Hôtel de France.

October 27.—Travelled by rail to Bayonne, and thence three miles to

132. BIARRITZ.

Walked up to the lighthouse, and found one of the keepers engaged in lighting his lamp, and the other smoking a cigar and watching the last rays of the sunset behind the Spanish mountains.

Tailed the man in the balcony, told him of the order, and obtained permission to mount. The tower is built on a rock of considerable height, and is a very fine building. The keepers' dwellings are about the base, as at Cape Ferret; but there is no provision for lodging the families of the keepers, who live in the town in their own lodgings. The building appeared to be rather extravagant than otherwise, but not to equal the British lighthouses in providing for the comfort of the keepers, though the accommodation is ample for single men. The tower, as at Cape Ferret, is mounted by a corkscrew stair. The floor is of coloured marbles. The illuminating apparatus is revolving, a system of 16 lenses showing a flash every $\frac{1}{2}$ minute, and a system of 8 rows of plane mercurial mirrors above and below. The light shows all round, and a considerable portion (nearly one half) is lost on the landward side. The mirrors were damaged, and some displaced; the whole was inferior to many of the English lighthouses of modern construction. The lamp was the same as at Cape Ferret, and the flame exceedingly bright and clear. The keeper seemed perfectly to understand his business, and to take a pride in it. He said that the flame would be better when the oil got heated, and he varied it by moving the regulator in the iron chimney, so as to show the ill effects of too much or too little draught.

The men consider themselves to be ill paid, on account of their responsibility. They have no allowances beyond their pay, and they find it hard to subsist on that. They are not changed from place to place, as in England. The lighthouse was very clean, but inferior in that respect to many in Great Britain which the Commissioners have seen.

The lights of Fontarabia and St. Sebastian were very clearly seen, distant many miles.

On returning to the hotel tested the light with the dark prism from the window, distant about a mile. A wax candle, distant 21 feet, gave 4·20, lighthouse flash 3·50, fixed light, 2·80. At about half a mile inland the light was still brighter, and threw strong shadows from the trees on the road. As this point was *above* the lighthouse, and considerably *above* the level of the sea, it is evident that here, as elsewhere, the greater portion of the light is thrown upwards, and never reaches the sea, while nearly one half is thrown over the land, where it is not wanted at all. A small reflector, fixed inside the lenses on the land side, would be some economy, and could be placed without any difficulty. Very few birds are killed here.

The result of these two comparisons is by no means unfavourable to the condition and efficiency of English lights of the same class.

October 28th.—Travelled by diligence to St. Sebastian, observed the light showing directly along the road; it was very bright, but was certainly not wanted there.

October 29th.—Walked up to the lighthouse

133. FARO DE YEULDO.

It is a white tower on the hill to the west of the port—a low tower with comfortable dwellings attached; there is no ornament, but it is very neat and remarkably well kept. The apparatus is third class dioptric fixed with three flashes, pro-

Spain.

duced by a system of revolving cylindrical prisms made in Paris by Le Pautre, the period of revolution $\frac{1}{2}$ minute; the lamp is mechanical, and has two wicks. About one fifth of the light is lost on the hill behind the house, and, though this light is about 500 or 600 feet above the sea, it is set to throw a horizontal beam. This method of throwing a flash has not been adopted in any English lighthouse that has been visited, and the result is satisfactory, for the light with two wicks was clearly seen at Biarritz, distant many miles. There are two guardians, whose pay is 5,000 reals. The one who showed the light seemed satisfied. There are no meteorological instruments. There is a lightning conductor. No books are provided; there is a clock, but no dial. The keeper is a mechanic and a musician, and seemed to be a very intelligent man; his light was remarkably well and neatly kept. The oil burned is olive oil, which costs 68 reals the aroba. The keepers are provided with arms, and the lower windows are barred. The court is covered with glass, and the rain water is collected and used. Returned to St. Sebastian direct, and drove in a carriage to Passages, a small town about three miles to the eastward; it is built on both sides of a very narrow entrance between two hills of about 1,000 feet. The passage leads from the sea into a considerable basin.

Hired a boat and rowed same distance to seaward, landed, and walked up a very steep hill, and then along a sheep walk overhanging the sea to the lighthouse. It is built on a peak overhanging the sea, about 550 feet above the level. There is good accommodation for the two keepers, who were profuse in their offers of hospitality. One has a wooden leg, the other has his full complement of limbs, and both appeared to understand their business, and to be intelligent men; one played several airs on a guitar. Their dwellings were not very clean, and their diet seemed to be spare; everything belonging to the light was in extremely good order, and they seemed to take a pride in it. Here, as at St. Sebastian, there were spare lamps ready for use, and everything in order and in its proper place, as in well-kept lighthouses elsewhere.

The register is the same as in France, and has a column for recording the appearance of other lights visible. The light is fixed, 4th order dioptric, two wicks made in Paris; set for horizontal beam, and a great part of the light lost on the hills behind. The keeper here, as at the other light, pointed out that a door to act as a reflector would materially improve the light. There are no meteorological instruments; there is a clock, and the hours for lighting and extinguishing are specified. Arms are provided, and the windows are barred. Keeper stated that these precautions were against "ladrones" (robbers), and that he was a little of a soldier. They see many ships passing sometimes close to the rocks, but there have been no wrecks. There are no fog signals at either of these lighthouses. Both are in excellent condition, and are fully equal to lights of similar classes elsewhere, which was not anticipated. The keepers stated that the lights to the westward were of a larger class, and quite as well kept.

Returned in a violent storm of wind and rain, rowed to Passages, and drove to St. Sebastian, where three steamers were waiting to embark a number of soldiers for Morocco. In the night one of these was forced to put to sea, and a large coaster was driven on shore in the harbour.

On the 28th gave a number of Mariners' Questions to the consul at Bilbao, who happened to be in the hotel.

October 30th.—Travelled to Bayonne.

October 31st.—Rail to Bordeaux.

November 1st.—Steamed down the river to

134. ROYAN;

heavy sea and bad weather at the mouth of the river. The buoyage of this very difficult navigation was

Flame.

Photometry.

Direction of
beam.

Birds.

France.
voyage.

remarkably defective. The buoys were few and far between, and small, but coloured on the usual French system. Observed the floating lightvessel, which was small, and similar to the Humber lightvessel. On landing hired a carriage, and drove to Pontillac, where the sand was so heavy that the carriage was left.

135. MALAKOFF.

toptric.
d light.

Walked in the dark to the lighthouse, which the Commissioners had been advised to inspect as worthy of their attention. It is a lofty construction of wooden beams, forming a pyramid, with a stair, and an iron room on the top containing the light. The keepers (two) have their dwellings at a distance of about 300 yards; walked to the door, got one of the keepers to accompany us, and ascended the tower. It was blowing very hard: there was no one in the building, and the doors were unfastened. The light is alternately red and bright, produced by three lamps in the focus of three large parabolic reflectors of cast copper, with galvanized silver. These were very dim, badly cleaned, and inferior in every respect to the worst reflectors seen in England. Their diameter is three feet, or rather more. The variation in colour is produced by two screens of red glass, which revolve horizontally on arms at right angles to an upright axle. On the top is a screen of metal, which masks the upper light when the two lower reflectors show bright. The upper reflector has a red glass chimney. Two bright lights are considered equal to three red; but according to the account of this light given by

d light.

against the sky was not nearly so distinct as a neighbouring church steeple coloured black, as a sailing mark. The light was grey and the sky covered with clouds.

The Tour de Balene is built on the northern extremity of the island. It is of yellow stone, with ornaments of dark grey granite. The tower is octagonal, and rises from a set of buildings two stories high, which contain numerous rooms, some of which are retained for the use of the authorities who visit the lighthouse. They were plainly but well fitted and furnished. It reminded the chairman of the lighthouses near Dublin and Edinburgh. The oilroom and workroom were equally remarkable for their elegant fittings, pavements of coloured marbles, and tables of the same material, glass cases for the necessary tools, spare lamps, wicks, &c. The guardian stated that the workroom was not used for cleaning the lamps, as it is at the bottom of the tower. The tower is 50 metres in height, hollow like the rest, and ascended by a turning stair. Below the lantern is a room with a spare lamp ready for use, and a bed for a guardian. This room is wainscoted with flowered oak, and is extremely handsome. It was subsequently stated by Mons. Reynaud, that he thought a little ornament of great practical use, as it makes the men more careful and more proud of their work. The lantern is also paved with coloured marble, and slabs of the same material line the walls to the height of about six feet. The guardian explained that this was intended to prevent dust.

Colour of building.

Ornament.

The gallery outside is broad and surrounded by a

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to go off. It was stated that mirrors are still used as part of the illuminating apparatus. Travelled by diligence to Rochfort and by rail to La Rochelle.

November 3rd.—Up at six, started at eight in a small steamer, and crossed to St. Martin, Isle de Rhé, in 1½ hours; hired a carriage and drove 12 miles to the large lighthouse

a distance of about an inch above the wick. The diameter of the apparatus is about six feet; ventilation is obtained by doors opening below the glass of the lantern. These are used whenever the lantern is observed to be dim from condensation of vapour produced by combustion. Small birds are taken in numbers. The keeper described them as fluttering against the glass till they rested on the stonework outside, always with their beaks against the glass. The guardians go outside, catch them and eat them. There are five guardians attached to these two lighthouses, under the superintendence of a chief, who is a native of the island. This whole establishment is extremely handsome and very well kept. The apparatus is equal to any in England, but not superior to Lundy Island, Rathlin, Skerryvore, and other first-class British lights which have been visited. There is a lightning conductor, an aneroid barometer, a clock; but there are no means of communication between lantern and dwellings. No books are provided for the men. The register was well and neatly kept.

Birds.

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139. TOUR DE BALENE,

139 on the list of lights visited or seen alight. Observed in crossing a beacon tower built on a reef; it was coloured in horizontal stripes red and black, with a white stripe close to the water. It was remarked that this produced the effect of a boat under sail with the sky showing underneath, proving the advantage of dark colours for objects intended to be seen against the sea or sky. A white lighthouse seen

France.
voyage.

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135. MALAKOFF.

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November 2nd.—Visited Monsieur Botton, the district engineer, who gave a great deal of information as to the mode of conducting the lighthouse service, which will be given in detail by the authorities. Looked at Cordouan through a telescope, as it was quite inaccessible in consequence of the heavy sea. The tower is coloured white; the sea was breaking heavily all round the lighthouse, and it was impossible to go off. It was stated that mirrors are still used as part of the illuminating apparatus. Travelled by diligence to Rochfort and by rail to La Rochelle.

November 3rd.—Up at six, started at eight in a small steamer, and crossed to St. Martin, Isle de Rhé, in 1½ hours; hired a carriage and drove 12 miles to the large lighthouse

139. TOUR DE BALENE,

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139 on the list of lights visited or seen alight. Observed in crossing a beacon tower built on a reef; it was coloured in horizontal stripes red and black, with a white stripe close to the water. It was remarked that this produced the effect of a boat under sail with the sky showing underneath, proving the advantage of dark colours for objects intended to be seen against the sea or sky. A white lighthouse seen

against the sky was not nearly so distinct as a neighbouring church steeple coloured black, as a sailing mark. The light was grey and the sky covered with clouds.

The Tour de Balene is built on the northern extremity of the island. It is of yellow stone, with ornaments of dark grey granite. The tower is octagonal, and rises from a set of buildings two stories high, which contain numerous rooms, some of which are retained for the use of the authorities who visit the lighthouse. They were plainly but well fitted and furnished. It reminded the chairman of the lighthouses near Dublin and Edinburgh. The oilroom and workroom were equally remarkable for their elegant fittings, pavements of coloured marbles, and tables of the same material, glass cases for the necessary tools, spare lamps, wicks, &c. The guardian stated that the workroom was not used for cleaning the lamps, as it is at the bottom of the tower. The tower is 50 metres in height, hollow like the rest, and ascended by a turning stair. Below the lantern is a room with a spare lamp ready for use, and a bed for a guardian. This room is wainscoted with flowered oak, and is extremely handsome. It was subsequently stated by Mons. Reynaud, that he thought a little ornament of great practical use, as it makes the men more careful and more proud of their work. The lantern is also paved with coloured marble, and slabs of the same material line the walls to the height of about six feet. The guardian explained that this was intended to prevent dust.

The gallery outside is broad and surrounded by a solid rail. The second lighthouse, built on a reef covered at high water, distant about a mile and a half, was observed. It was of grey granite, and appeared almost black, because wet. Two keepers live for a short period in this tower, and when relieved they are lodged on shore in neat houses built close to the large tower, in a garden sheltered by tamarisks. Their wives and families were seen. Also a system of spurs of brickwork projecting into the sea, intended to cause the sand to accumulate and prevent the damage which the sea might cause in heavy gales. A curious effect of a cross sea was pointed out by the keeper, who said that strangers generally remarked that they had never seen anything similar. It was sufficiently evident that the second light could not be visited, as the sea was breaking all about it in lines of breakers, moving at right angles to each other.

The illuminating apparatus was constructed by Sautter and Co., Avenue Montaigne à Paris.

It is dioptric, first order, and consists of a system of 16 revolving lenses, with prisms above and below, to give the fixed light. It shows all round, and gives a flash every 30 seconds. The brass fittings are bright. The lamp is mechanical, with four wicks, and pump, carefully levelled and accurately set in the focus by the spirit level and string. The focus is at a distance of about an inch above the wick. The diameter of the apparatus is about six feet; ventilation is obtained by doors opening below the glass of the lantern. These are used whenever the lantern is observed to be dim from condensation of vapour produced by combustion. Small birds are taken in numbers. The keeper described them as fluttering against the glass till they rested on the stonework outside, always with their beaks against the glass. The guardians go outside, catch them and eat them. There are five guardians attached to these two lighthouses, under the superintendence of a chief, who is a native of the island. This whole establishment is extremely handsome and very well kept. The apparatus is equal to any in England, but not superior to Lundy Island, Rathlin, Skerry More, and other first-class British lights which have been visited. There is a lightning conductor, an aneroid barometer, a clock; but there are no means of communication between lantern and dwellings. No books are provided for the men. The register was well and neatly kept.

France.

Colour of build-
ing.

Ornament.

Birds.

France.

Drove back to St. Martin's; hired a fishing-boat, and sailed for La Rochelle, at 5-15, arrived at 10-25, head wind and considerable sea. Observed the lights of, 2, La Balene; 3, St. Martin red harbour light; 4, La Flotte white ditto; 5, Aiguillon; 6, Chauvan; 7, Chasseron; 8, Isle d'Aix; 9, 10, harbour lights of La Rochelle. 149. These latter were very useful, and were greatly superior to lights of their class in England, such as Littlehampton, Aberdeen, Dunmore, near Waterford, &c. One is red, the other revolving bright, and when both are in one the harbour is open.

November 4th.—La Rochelle to Paris.

November 5th.—Called on Mons. Reynaud, and finding that he was at the At  lier des Phares, followed him there; found a Commission of members of the Government and scientific bodies engaged in an examination of the electric light.

Mons. Reynaud stated that they had succeeded in increasing the power of the light, so as nearly to double its intensity, and that by dividing the machine into two parts they had avoided the danger of extinction. The experiment under trial appeared to be a comparison between a single Argand burner, a four-wick lighthouse oil lamp, with a lens of the first order used to produce a flash, and the electric light in the focus of a cast lens on the new system for producing a fixed light; that is to say, 1st, the light used in a single reflector; 2nd, the most powerful light that is now produced in lighthouses, on the dioptric system, involving a first cost of about 1,000*l.* for apparatus, and a cost of 875 gallons of oil per year for fuel; 3rd. The electric light in an apparatus about the size of a hat, costing about 20*l.* or 30*l.*, intended to cast a horizontal disk of light, and produced at the cost of the motive power of the engine, wear and tear of the machine, and cost of engineer.

The superiority of the electric light was beyond all comparison. According to the calculation of the engineers the figures were, at the former experiment:—

Argand burner. 1.

First order flash, 80 to 90.

Electric light, 94.

Electric light, cast glass flash, 55,000.

Ditto first order flash, 220,000.

Ditto doubled (2), 440,000.

Ditto fixed light, small apparatus costing 20*l.* or 30*l.*, figures not given, but the light was so intense as to be painful to the eyes, and to obliterate the shadow cast by the first order flash with an oil lamp of four wicks placed near it, and at the same distance. The light was steady. A report will probably be given, and should be obtained if possible.

It does not appear that steam power is necessary to move the machine which produces the current of electricity. A weight and a system of wheels would probably give sufficient power and velocity. If this can be accomplished, the electric light seems to be far superior to any other artificial light known.

Tuesday 8th.—Observed the harbour light Boulogne, Grisnez, and South Foreland at about 6 A.M., day breaking. The stars were nearly all invisible in the light, consequently the South Foreland electric light, fixed light apparatus, was then, at a distance of 29 miles, superior in brilliancy to the stars. The fishermen all consider the new light an improvement, and remark that the colour is *blue*. The sailors on board the steamer remarked that they see the electric light about seven miles further than the other in thick hazy weather.

The Commission crossed the Channel, and returned to London.

(Signed) W. A. B. HAMILTON.

Captain Ryder visited France, and reported as follows:—

Observations by
Captain Ryder

150. MARSEILLES.

13th October.—Visited the pier lighthouse of the harbour of La Joliette. Catoptric, fourth order. No fog or telegraph signals. Lamp very clean. Keeper absent at his trade.

14th.—Visited the lighthouse at Cassis, and afterwards the two lighthouses at Ciotat.

15th.—Had an interview with the Secretary of the Pr  fet Maritime at Toulon, who passed me on to the Engineer des Travaux, in the dockyard; who passed me on to the assistant of the Engineer des Travaux Publiques, who gave me two orders for Lesset and La Porquerolles.

16th.—A very wet morning. Started for small steamer appointed to sail on that day at 7 a.m. for Porquerolles. Found that her machine had broken down, and she would not start until Tuesday in next week. Returned to Paris to meet Commissioners.

151, 152. CASSIS AND CIOTAT.

The two lighthouses at Ciotat (a very valuable harbour, where are situated the buildings of the Messag  ries Imp  riales), and the one lighthouse at Cassis (another small harbour), are good specimens of lights, which from their brilliancy must be useful as coast lights, although more accurately they would be considered only as harbour lights. They, like La Joliette, are 4th order; but La Joliette alone had a reflector back. The houses are small, just room enough to turn up stairs. The lamps and lenses are always carefully covered in the daytime, and the blinds drawn. The keepers are in every case, as regards these harbour lights, allowed to follow a trade during the day, which permits of their receiving a low pay.

There was only one point which caught my attention, and which if valuable, may be adopted by us; viz., a tin filter for the oil. In visiting our own Filter. lighthouses we occasionally noticed that the oil was thick and dull. This might probably be corrected by a filter.

I made no inquiries as to management, &c., deeming that all such queries could be best answered at Paris.

Examined at Marseilles, Captain Roberts, of the "Vectis," Peninsular and Oriental.

He stated that he had answered our questions, and gave as his opinion that the French lights appeared to him to be more brilliant than the English; but not being asked to give his reason why they were so, had not stated what was the reason of his opinion, viz. that the lights, from being in the Mediterranean, where the atmosphere was so clear, showed much further, and could therefore be placed at greater heights. He considered the Porquerolles a very good light; he had seen it 25 miles off. The Sangonez, on the coast of Corsica, was also a very good light, and had seen it 30 miles off; Genoa light also he had seen 30 miles off. Where the atmosphere is clear the lights can of course be placed higher, and therefore can be seen further off.

The greater height and the clearness of the atmosphere are calculated to elicit a very favourable opinion of the French lighthouses, and to make the English lights—necessarily placed lower, and therefore not seen so far off—owing to that cause and to the less clear atmosphere, compared with the French at a disadvantage. *Note.*—This is true when French lights in the Mediterranean or the south coast of France are compared with lights in England, but cannot apply to any comparison between lights that belong to the two countries, and are situated in the English Channel.

He thinks Gozo light, in the island of Malta, as good as any French light.

Captain Roberts thinks a good light at the east end of Malta would be a great advantage to vessels coming from the eastward.

Oral Evidence

Harbour lights
good.

Electric light.

Motive power

Electric light.

Observation.

the lamp whenever they thought so, as in thick fogs, &c. M. Arqueville evidently prided himself on his lighthouse, and had made a hobby of the duties connected

VILLE near HONFLEUR.

dioptric with red flashes, caused containing cylindrical convergences.

grey colour, although intended as ships at sea.

buildings handsome, and grounds There was a café close to the some of the family. There were ts for the engineer, who only r days. This lighthouse was con- aud to be a very important light. luck with the order and regularity

There was a very large assort- glass press in the waiting room. e towels, wicks, &c., were all the press.

ed list of everything in each room ce. The head keeper stated that ne made the flame burn irregu- he said, the moderator principle, ards at Honfleur.

tor, but it was very dull. There n the centre of the roof and no e soot was constantly falling, as if imperfect.

ouge powder for reflector occa- ily a white powder, called poudre l like whiting. He stated that t like the reflectors to be very

il consumed every watch is mea- by a steel scale being placed in

producing the rotatory motion perfect. It will go for 20 hours, ery night. The small machine ound up every three hours.

keepers; they may work in the not sleep out at night without

in all the larger lighthouses, an chamber immediately under the ded for and most suggestive of keeper it was stated remained in guard was always in the lantern pay of the three keepers were 5,600 francs, or 32*l.*, 29*l.*, 24*l.*, y receive in our service.

ot appear to reside in the light- is probably, therefore, a charge ceases the disproportion between o countries.

lighting and use of furniture.

meter and thermometer, and eight ade in the 24 hours.

cept of the strength of the wind, e clouds.

rain gauges.

inspected twice a month by the ear by engineer, and once in two and or Mr. Reynaud. The light- their own doctors generally; but

at some of the lighthouses the engineers allow them advice gratis; it depends on the engineer.

There is a superannuation after very long service.

The keepers said new oil was always tried in a small lamp with a wick supplied for the purpose, and if it did not burn well, was returned.

The rule for lighting was a quarter of an hour before sunset, and for extinguishing, at daylight.

Everything beautifully clean; but not more so

(2.) Honestly expending the oil, is evidently in the order given. If, therefore, there is a rogue in charge of a lighthouse, it is better that he should keep the most brilliant light possible, even though he sells some of the oil. Any very rigid and safe system of scrutiny would lead the rogues (who know that their chiefs are well aware what the maximum consumption should be), to obtain their surplus disposable oil by diminishing

France.

harbour lights
od.

Drove back to St. Martin's; h
and sailed for La Rochelle, at 5.1.
head wind and considerable sea.
of, 2, La Balene; 3, St. Martin
4, La Flotte white ditto; 5, Aigu
7, Chasseron; 8, Isle d'Aix; 9, 1
La Rochelle. 149. These latter w
were greatly superior to lights of
land, such as Littlehampton, A
near Waterford, &c. One is red,
bright, and when both are in one

November 4th.—La Rochelle to

November 5th.—Called on M
finding that he was at the At  lier
him there; found a Commission
Government and scientific bodi
examination of the electric light.

Electric light.

Mons. Reynaud stated that the
increasing the power of the lig
double its intensity, and that by d
into two parts they had avoided t
tion. The experiment under tria
comparison between a single Arg
wick lighthouse oil lamp, with a le
used to produce a flash, and the
focus of a cast lens on the new sys
fixed light; that is to say, 1st,
single reflector; 2nd, the most
is now produced in lighthouses
system, involving a first cost of ab
ratus, and a cost of 875 gallons
fuel; 3rd. The electric light in a
the size of a hat, costing about 20/
cast a horizontal disk of light, a
cost of the motive power of the
tear of the machine, and cost of c

The superiority of the electric
all comparison. According to th
engineers the figures were, at
ment:—

Argand burner, 1.

First order flash, 80 to 90.

Electric light, 94.

Electric light, cast glass flas-

Ditto first order flas

Ditto doubled (2), 4

Ditto fixed light, sm

20l. or 30l., figures not given, b
intense as to be painful to the ey
the shadow cast by the first ord
lamp of four wicks placed near
distance. The light was steady.
bably be given, and should be obt

Motive power

It does not appear that steam
to move the machine which prod
electricity. A weight and a syst
probably give sufficient power an
can be accomplished, the electric
superior to any other artificial lig

Electric light.

Tuesday 8th.—Observed the
logne, Grisuez, and South Forela
day breaking. The stars were ne
the light, consequently the Sout
light, fixed light apparatus, was tl
29 miles, superior in brilliancy
fishermen all consider the new lig
and remark that the colour is bl.
board the steamer remarked that
light about seven miles further tha
hazy weather.

Observation.

The Commission crossed the Ch
to London.

(Signed) W. A. B. HAMILTON.

r France are compared with lights in England, but
cannot apply to any comparison between lights that
belong to the two countries, and are situated in the
English Channel.

He thinks Gozo light, in the island of Malta, as
good as any French light.

Captain Roberts thinks a good light at the east end
of Malta would be a great advantage to vessels
coming from the eastward.

Prefers revolving lights, as they cannot be mistaken for ship's lights.

The light at Fort Tinc, Quarantine Harbour, has been most unaccountably delayed. The lamp has been returned to England, and he hears it will not give satisfaction. Captains not been consulted about it.

St. Alban's Head, south coast of England, ought to have a good light.

Portland lights are not powerful enough. Was not aware of lightship being placed there.

24th October.—Cherbourg visited by Captain A. P. Ryder, Mr. Graves, and Dr. Gladstone.

153. QUERQUEVILLE LIGHT.

Dioptric, fourth order; in the fort near Cherbourg. The keeper and his wife both intelligent people; live in a house in the fort. They alluded to having moved in a higher sphere, and being reduced.

He breaks, on an average, one chimney in about eight months. He says when they become permanently dull he breaks them purposely.

He effects an economy by stretching, and thus thinning the wick. It burns brighter with less oil. He considers that he effects a saving of one-sixth of the oil in this way. He cleans the glass with spirits of wine; it was certainly very clean. A linen cover is kept over it all the day.

His lighthouse is inspected twice a month by the local agent, one of the employés in the engineer department.

He stated that he never had to touch the light during the night.

The oil was kept in a double cistern. The cistern was lined with zinc, which colours the oil; but he spoke of a superior description, lined with porcelain. There was a wooden scale in the cistern. He spoke of an improved scale, which was marked as the oil was poured in, and was therefore more accurate.

He always empties his lamp every morning into the filter, and from thence the oil is transferred to the cistern.

Every two months he washes the cloth at the bottom of the filter, and bakes the sand.

He is very careful in cleaning his lamp, and has small brushes of his own which he passes through the oil pipe to clear the passage, into which pieces of burnt wick sometimes find their way.

He uses burnt brick instead of rouge, as he says rouge gives a tinge to the brass which makes the light yellow. He considers it important to have all metal as bright as possible, so that every ray may be reflected.

He stated that the last keeper very much neglected the light, and stole the oil.

Great precautions are taken to estimate the consumption. The lamp is weighed just before it is lighted, and also when extinguished; the difference is the weight of the oil. This is registered. The sums of these weights during any interval ought evidently to equal the decrease in the weight of the oil in the cistern; but no precaution of this kind can prevent a lighthouse keeper, where there is only one, from selling the oil, as it is evidently in his power to cook his accounts. There is the following danger in watching the consumption of oil too narrowly:

The relative importance of the duties of a lighthouse keeper, viz.,

(1.) Keeping the most brilliant light possible,

(2.) Honestly expending the oil,

is evidently in the order given. If, therefore, there is a rogue in charge of a lighthouse, it is better that he should keep the most brilliant light possible, even though he sells some of the oil. Any very rigid and safe system of scrutiny would lead the rogues (who know that their chiefs are well aware what the maximum consumption should be), to obtain their surplus disposable oil by diminishing

the brilliancy of the lamp whenever they thought they could safely do so, as in thick fogs, &c.

The keeper at Querqueville evidently prided himself very much on his lighthouse, and had made a special study and hobby of the duties connected with it.

154. FATOUVILLE near HONFLEUR.

A first-class catadioptric with red flashes, caused by a revolving frame containing cylindrical converging lenses and red panes.

Lighthouse tower grey colour, although intended as a guiding mark for ships at sea.

The lighthouse and buildings handsome, and grounds very nicely kept. There was a café close to the lighthouse, kept by some of the family. There were handsome apartments for the engineer, who only comes there for a few days. This lighthouse was considered by Mr. Reynaud to be a very important light.

We were much struck with the order and regularity of the arrangements. There was a very large assortment of tools in a glass press in the waiting room. Spare glasses, spare towels, wicks, &c., were all orderly arranged in the press.

There was a framed list of everything in each room hung up for reference. The head keeper stated that the pumping machine made the flame burn irregularly. He preferred, he said, the moderator principle, which we saw afterwards at Honfleur.

There was a reflector, but it was very dull. There was only one hole in the centre of the roof and no upper chimney. The soot was constantly falling, as if the consumption was imperfect.

The keeper used rouge powder for reflector occasionally; but ordinarily a white powder, called *poudre d'Espagne*; it looked like whitening. He stated that Mr. Reynaud did not like the reflectors to be very bright.

The quantity of oil consumed every watch is measured and registered by a steel scale being placed in the lamp.

The machine for producing the rotatory motion appeared to be very perfect. It will go for 20 hours, but is wound up every night. The small machine for supplying oil is wound up every three hours.

There are three keepers; they may work in the day at a trade, but not sleep out at night without permission.

We saw here, and in all the larger lighthouses, an arm chair in the chamber immediately under the lamp, evidently intended for and most suggestive of a nap. The second keeper it was stated remained in bed while the one on guard was always in the lantern or the chair. The pay of the three keepers were respectively 800, 725, 600 francs, or 32*l.*, 29*l.*, 24*l.*, about half what they receive in our service.

The families did not appear to reside in the lighthouse. House rent is probably, therefore, a charge which still further increases the disproportion between the salaries in the two countries.

They receive free lighting and use of furniture.

There was a barometer and thermometer, and eight observations were made in the 24 hours.

A record is also kept of the strength of the wind, and the nature of the clouds.

There were four rain gauges.

The lighthouse is inspected twice a month by the conductor, twice a year by engineer, and once in two years by Mr. Degrand or Mr. Reynaud. The lighthouse keepers pay their own doctors generally; but at some of the lighthouses the engineers allow them advice gratis; it depends on the engineer.

There is a superannuation after very long service.

The keepers said new oil was always tried in a small lamp with a wick supplied for the purpose, and if it did not burn well, was returned.

The rule for lighting was a quarter of an hour before sunset, and for extinguishing, at daylight.

Everything beautifully clean; but not more so

France. than in our first-class houses in England or Scotland, and some in Ireland.

Red light. Saw this light from Honfleur six miles off; red flashes very brilliant.

155. HONFLEUR.

An English resident at Harfleur, and accustomed to navigate the Channel in a yacht, expressed his opinion that the English coast was better lighted than the French, because the lights were situated in more useful positions, and were better distinguished from one another. He said that the French navigated by the lead, and made comparatively little use of the lights.

From the pier at Honfleur 11 different lights, besides red lanterns on piers, were observed that night in different parts of the Seine, including those of La Heve, which were very bright.

The buoys in the Seine appeared few and small; none on any of the sand banks.

Visited the Phare de l'Hopital; third order; fixed; two wicks.

Moderator lamp; no metal chimney running to roof.

The moderator has a small filter, to prevent dust being forced up by piston to the wick.

The oil is measured with a steel measure every watch.

The lighthouse keeper, Victor Hclane, was an old soldier who had served in the Russian campaign; lost his pension on coming into the lighthouse service. His pay was 650 francs, 26*l*. House said to be inconvenient; no room.

Fatouville is two leagues off; cannot see it in a fog.

26th Oct.—Crossed the Seine to Havre.

156. CAP DE LA HEVE.

Two lighthouses; very handsome, connected by a well-built row of dwellings. A permanent bazaar is established in the lower story. First class dioptric, fixed.

Fresnel's upper and lower mirrors. Pumps for oil very clean and in good order.

There were five keepers. The head keeper kept no night watch, but visited the houses occasionally. The oil is measured every hour. The consumption of oil appears to be considered as the measure of efficiency, and any keeper would be blamed as having neglected his duty if the consumption had not reached the required figure during his watch.

The lighthouses are of the same height. Their being in one was said to mark the position of some shoal.

This is said to be the site of the earliest lighthouse in France. A coal fire was burnt here till 1790.

27th Oct.—Proceeded to Dieppe, and visited at night the lighthouse at

157. AILLY.

This is considered by M. Reynaud to be one of the very best lights in France.

1st order; catadioptric, revolving.

The flash is prolonged by the totally reflecting prisms of the upper part of the apparatus not being perfectly concentric with the annular lenses. There are large reflectors on the landward side, which, however, were very dull.

In very good order. Light very brilliant. The windows were very dirty. No novelty of any kind was elicited by our visit.

General opinions.—The internal arrangements of the French lighthouses appear to be perfect.

The dullness of their reflectors in the catadioptric lights appears the only exception to their uniform efficiency.

The lighthouses of the smaller orders are not so well provided with tools, &c., as the larger establishments.

The dioptric principle appears to be almost universal. The French when Fresnel brought for-

ward his principle were, unlike the English, almost without lighthouses. It was most economical, therefore, for them to place *dioptric* lights everywhere, the entire cost being soon covered by the economy in oil.

The frequency of the French lights is also very marked compared with the lights in the English Channel. If there is no confusion occasioned by this, there can be no doubt but that frequent lights are a great boon to navigators in thick hazy weather.

October 28th.—Captain Ryder and Mr. Graves crossed from Dieppe to Newhaven.

Captain White, of the Newhaven packet informed them that the only two lights he used were Cap L'Ailly in France, and Beachy Head in England, and he was constantly seeing them, losing sight of one shortly before he obtained sight of the other. He stated that the English was quite as good as the French.

Mr. Gladstone visited the lighthouse on the pier-head at

Observation
Dr. Gladstone

158. DIEPPE.

It is a fourth order, dioptric. It appeared clean and in good condition. The keeper lives in a house close by the pier, where he keeps his oil, stores, registers, &c. He complained that the zinc cisterns injure the oil, and said that the same had been remarked to him by the keepers at the Cap de L'Ailly. The oil was much better when kept in earthen jars. The last keeper had been discharged for inattention. The light is only burnt for two hours at high water.

From the pier at Boulogne Mr. Gladstone watched the light at Cape Grisnez. It shone clearly, and the alternation of bright and dull light produced a good distinction.

October 29th.—As he could not manage to reach Cape Grisnez on account of the distance, Mr. Gladstone wrote to Admiral Hamilton to that effect, informing him of the means of reaching that place should he deem it expedient to do so. He had previously visited the lighthouse at Cap d'Alprêche, and that on the western jetty at Boulogne.

159. CAP D'ALPRECHE.

The establishment consists of a small tower containing a dioptric apparatus of the third order, a little house, and a garden, on the top of a very exposed cliff. The keeper, who is an intelligent and civil man, and his wife both complained of the cold and wind from which they suffer. The tower frequently sways to and fro with the wind, and the glass of the lantern is often cracked, and sometimes blown in, so that storm panes are always kept ready. The place appeared clean, and well kept, and the ventilation good. The rope of the revolving apparatus is very thin, but strong, and the keeper seemed greatly astonished that in Great Britain ropes sometimes break; he said that the rope ought to be examined from time to time, and changed if at all frayed. He is not furnished with proper means for weighing the oil. The conductor comes frequently, perhaps once a month; the engineer occasionally. The South Foreland lights are seen from this tower.

160. BOULOGNE.

The tidal light establishment on the western jetty at Boulogne comprises an iron tower, a wooden house for the keeper, and a zinc bell-house. The keeper is an ignorant man who cannot read; his son-in-law keeps the registers. At different heights up the tower and facing the sea are two windows, each provided with a very small dioptric apparatus. They were in a very sooty condition, apparently from the want of ventilation. The lighting of these indicate the state of the tide, which is ascertained by a pole attached to a float, which rises and falls along a graduated scale on the wall of the keeper's house. There is an Argand lamp in a window towards the town, which is lighted merely to show that the keeper is there. Things looked badly cared for throughout the establishment, and the keeper did not know the time.

Tidal light.

Oral Evidence.

Buoyage.

Tidal light.

Measure of
light.

Remarks.

fog signal
reflector.

The bell is in the centre of a large parabolic reflector built into the house, and facing the sea. It seems to be of iron covered with some white composition. It is struck by three hammers alternately, which are worked by machinery, the motive power being a falling weight that has to be wound up every half hour. It has a clear sound, but did not give the impression of being very loud even when heard from the front of the reflector.

There are buoys on each side of the channel outside Boulogne Harbour; but they are small and do not watch well.

September, 1859.—Captain RYDER and Mr. GRAVES visited the following lighthouses in IRELAND and SCOTLAND.

IRELAND.

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161. THE HOOK.—No. 135.

19th September 1859. 7 a.m. The illuminating apparatus is catoptric with twenty-one burners. The reflectors were very old. The head lighthouse keeper, Peter Page, appeared intelligent; he had been twenty-nine years in the service of the Ballast Board. His previous profession had been bookbinding. His pay was 64*l.* 12*s.* 4*d.* per annum, and the assistant received 46*l.* 3*s.*, but it cost them 2*l.* a year to send for their provisions.

see page 18.

There was no lightning conductor. It is remarkable that we find no record of lighthouses having been struck by lightning, although many of them have no conductors. There are two fog bells rung by machinery. The keeper thought that one, placed on the point, would be heard better. The sound from one bell appeared to be much obstructed by a portion of the wall which projected in front of it. There were no signals; the keeper suggested, and we afterwards received evidence tending to show, that a tide signal at the Hook to indicate when the bar was passable for large vessels, would be much valued. The oil appeared to be clean and good. The chimneys are broken at the rate of about 150 to 200 in the year. The water consumed by the keepers is rain water collected in a cask. They are not supplied with filters. A cistern had been received some weeks prior to our visit, but no one had arrived to erect it.

ater.

medicine, &c.

The lighthouse is inspected once a year by the Engineer and some of the Commissioners. Medicine chests are not supplied in Irish lighthouses. Each keeper is allowed an acre of land in which to grow vegetables. No wreck has taken place within sight of the lighthouse for 4 years.

The paint was in fair order, but the tower, an edifice of very considerable age, appears to admit the damp readily, the walls being covered with damp marks. A barometer, thermometer, clock, and sun dial were on the premises.

The ventilation appeared to be very imperfect, the smoke settling on the windows and top.

The accommodation for the keepers who lived in the tower was very indifferent, two rooms only for each family. The time for lighting the lamps was sunset, and for extinguishing them sunrise, this by almanac if sun is not visible. They had a small number of books supplied to them, but they had not been changed in 6 years.

There was a great deal of brasswork about the lamps and reflectors, which was kept highly polished. The reflectors were removed once in 6 months for the purpose of giving a thorough polishing to the silvering, but every week to polish the backs. In some lighthouses the brasswork is allowed to become a natural bronze colour, and is rarely cleaned. This saves much risk to the reflector. No tools of any kind are supplied.

There appeared to be a great deal of rotten wood in the lantern framework.

This lighthouse has been supplied with new patterned lamps, which, however, leaked, and the oil

I.

dropping on the reflectors, injured their reflecting powers. Small cups required to be fitted to catch the oil.

Ireland.

The keeper stated that 1 argand lamp burnt about 1 pint in 12 hours.

The keeper thinks the rocky point consisting of limestone is being blasted away too much, as in gales of wind the sea now breaks much higher than it used to do.

Examined the oil account to see if there was any great difference between the expenditures in the oil different years. 1856, 812 gallons; 1857, 812 gallons; 1858, 823 gallons. Again to compare months.

	1858.	1859.
January	96	98
February	78	78
March	71	71
April	55	57
May	48	47
June	39	38
July	46	45
August	55	58
September	65	
October	82	
November	91	
December	97	
	<u>823</u>	

Asked the keeper what was the largest amount of difference in gallons between the expenditures of two consecutive years which he thought would be allowed to pass unquestioned; would 50 gallons? Yes, he said. He should not expect any notice to be taken if his account one year was 50 gallons over his previous account, as there was a great difference between oils. The best oil burnt quickest. We then visited the

162. FORT DUNCANNON.—No. 136.

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It has three argands, and is situated in a corner of the fort. When in one with an inshore lighthouse, the line is a leading mark for crossing the bar. The keeper succeeded his father; as his presence is not required during the day, he receives only 21*l.* per annum. There are no lightning conductors. The paint was in good order, but the ventilation very indifferent.

163. NORTH DUNCANNON.—No. 137.

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The keeper here has 46*l.* a year. There was no lightning conductor. No water barrel or tank. The ventilation was very good, the house orderly, and lantern very clean.

164. MINE HEAD.—No. 140.

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Visited this lighthouse on 20th September, 5.45 p.m.

The illuminating apparatus is dioptric of the first order. The head keeper had previously been at Tuskar. No lightning conductor. No fog or telegraph signals. About 4 chimneys are broken in 12 months. The keepers and their families have to drink rain water, they have no filter, and require a cistern. The machinery revolves by aid of a rope, which has broken. It took 20 minutes to shift the rope working the lamp by hand all the time. No medicine chest was supplied, nearest medical man was 5 miles off.

Water.

In the means used for communicating from the lantern to the house of the keeper off duty, there is a marked difference between the lighthouses in Scotland, (all of which are fitted with voice tubes), and the lighthouses in England and Ireland; in none of the two latter did we observe any such arrangement. It requires only two minutes to shift the lamp.

Consumption of oil 400 gallons a year, less than half the quantity burnt at the Hook, where there are only 21 burners.

F

Ireland.

On the 20th September, at 9.15 p.m., visited the

165. YOUGHAL.—No. 141

Vol. II. 234. light. Its illuminating apparatus, is third order, fixed. The lighthouse keeper had been the butler of one of the Lighthouse Commissioners. He had apparently turned his experience in cleaning plate, &c. to good account. We were particularly struck with the neatness and polish of everything in and about the lighthouse. Receives 46*l*. a year. No lightning conductor, no signals of any kind. Breaks about 4 chimnies in 12 months. Burns 124 gallons in the year. Has no cistern for water, only barrel. Has not been inspected for more than two years.

The accommodation in his house and the ventilation of the lantern are very good.

On the 21st September, at 10.30 a.m., visited

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166. BALLYCOTTIN.—No. 142.

Water.

Dioptric, 1st order, intermittent. There are two keepers, one at 64*l*. the other at 46*l*. a year, and a fog bell winder at 36*l*. No lightning conductor. Breaks 2 chimnies a month. There is no water on the island, it is brought in a boat that is paid for attending on the lighthouse. A cistern which had been sent from Dublin, was not fitted. There is no medicine chest, the doctor lives 7 miles off, and the island is sometimes inaccessible.

The revolving machinery was very much out of order, the weights had in consequence to be increased to 15 cwt., and in consequence a new rope rove, which was already slightly chafed.

This had been reported at head quarters, but nothing was to be done until inspector made his visit. The weight of the machinery that rung the bell had a fall of only 12 feet, and required to be wound up every three quarters of an hour.

On 21st September, at 3 p.m., visited

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167. ROCHE POINT, QUEENSTOWN.—No. 143.

The illuminating apparatus is catoptric, fixed; 9 red chimnies to seaward, 8 white towards harbour. There is only one keeper. He has 12 children. Receives 64*l*. a year. Has repeatedly asked for an assistant. There are no signals. He breaks a chimney every night. There is no water cistern. The keeper complains of the hardship of having stone floors in his dwelling house. Everything at this lighthouse appeared to be in good order, all the reflectors were covered with brown paper. The accommodation is good for a small family. The keeper informed us that on one occasion a duck got into the lantern through the cowl, and fluttering round broke nearly all the chimnies, and put out the lamps.

As there are great complaints of this lighthouse not showing well beyond a short distance to seaward, we think it advisable to state that we saw no symptoms of neglect any where. If, however, lights require careful and constant attention to prevent them burning dull, we deem it probable that where there is only one keeper, considerable intervals will elapse without any attention being paid to the lights. It is not possible that in a long winter night of fourteen hours, one keeper can keep his attention constantly alive, he will, we believe, inevitably go to sleep.

21st September, 5 p.m.—Visited

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168. SPIT LIGHT, QUEENSTOWN.—No. 144.

Dioptric, 4th order, on iron piles. One keeper and an assistant. The lamp was in fair order. The keeper thought that some piles should be driven round the light to keep vessels from fouling it. It was stated that a more powerful light was going to be substituted for the present one.

23rd September, 3.20 p.m.—Visited the

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169. BEEVES ROCK LIGHT.—No. 155.
in the Shannon.*Ireland and Scotland.*

Dioptric. There are two keepers, one at 46*l*. and the other at 36*l*. There is no lightning conductor nor are there any signals. One glass a month is broken. There are no cisterns for the water, it is brought from the shore in a boat that is paid for attending on the lighthouse, seven and sixpence a week for two trips. The keepers who wish to go to church must pay their own way, no boat being provided.

The accommodation was good, but there was a want of bedsteads. There was a small library which had never been changed. Not been inspected for 2 years.

23rd September, 6 p.m.—Visited the

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170. TARBERT.—No. 154.

lighthouse.

Catoptric. 19 reflectors. One keeper at 64*l*. No lightning conductors or signals. Breaks 12 chimnies a month. Burns about 650 gallons a year. The pump water was reported not to be good. There was no medicine chest; the medical man charged the lighthouse keeper 1*l*. for every visit.

23rd September, 9 p.m.—Visited

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171. KILCREDINE.—No. 156.

lighthouse.

Catoptric 2d order burners. Ventilation not good, four more holes required. Porches to the doors would be great comfort to keep the wind out. There was a small library which had been lately changed. The keeper had 2 acres of land, kept 9 sleep and a cow. Depended on rain water.

24th September, 10 p.m.—Visited

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172. MUTTON ISLAND.—No. 160.

lighthouse.

Catoptric. 13 burners (bright). Keeper receives 64*l*. a year. Breaks 12 chimnies a month. Accommodation sufficient. Ventilation might be improved. This light is complained of as being very often the reverse of brilliant. There is only one keeper.

29 September, 7.30 a.m.—Visited

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173. HOLYWOOD

Water.

light. Belongs to Harbour Board, Belfast.

Dioptric (red). One keeper, who is also pilot master. Receives 2*l*. a week. Has two gongs, but both are cracked and almost useless. Has only broke one chimney in five years, owing to great care in gradually heating and cooling them and keeping them quite upright. The pilots live in the lighthouse, which is on piles. The lighthouse is inspected by the engineer to the Harbour Board twice a year. There have been no accidents, but the lighthouse has narrowly escaped injury from collisions. Ventilation good, but the glass dull on inside in damp weather. Accommodation poor. The bedroom chimney smokes so much that the fire cannot be lighted, and it is therefore very cold in winter.

There are four other lights, all of which were visited. They are called the DEKMOYLE light; the MICHAEL RANX light, so named after a previous keeper; —these two are on piles—and the two COTTAGE ISLAND lighthouses. There is one argand in each of the four. The keepers are superannuated labourers. The rooms they live in are generally very dirty, and the lights, which show through a cracked bull's eye, have a very neglected appearance, but the captains who pass them constantly say they are quite sufficient.

30th September, 8 a.m.—Visited the lighthouse on

Scotland

174. CUMBRAE TRUST

at the entrance of the Clyde. This lighthouse belongs to the Cumbrae Trust Commissioners.

Catoptric. 15 reflectors 21½ inches in diameter. They are removed twice a year to clean their backs. There are two keepers, one has 60*l*. a year, the other

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Scotland.

50*l.*, with gardens. There are no fog signals, but there are 3 small guns used for saluting, charge 1 lb. The keeper thought that if the guns were used as fog signals there would be an echo amongst the hills which would deceive the mariner as to the whereabouts of the signal. There is a cistern for rain. The light is inspected occasionally by Commissioners and secretary. The watches are four hours long; keeper rings a bell for relief; never leaves the lantern till relieved. The lamps are fitted to lower on a rod out of reflector, which admits of the latter being cleaned without removal.

30th September, 10.15 a.m.—Visited

175. TOWARD

light, belonging to the Cumbrae Trnst.

Catoptric, holophotal, revolving. 3 reflectors, 25 inches in diameter. The lenses were in front of, and attached to the reflectors.

The assistant keeper is boarded by the head keeper, the latter receiving 20*l.* a year for it, the former 6*l.*

There is a lightning conductor. Head light keeper has seen a great deal of lightning, has known bell wires to melt. Breaks one chimney a month.

Lighthouse is of iron, very damp. Lantern is to be lined with wood. There is an alarm in the light machinery, but neither spare lamp or bell for assistant. Accommodation fair. Ventilation good. The machinery goes for 9 hours, but is wound up every 4 hours. The rope is changed end for end every year till worn out; has never broke. Has chamois leather in bottom of chimney boxes, and consider that it prevents the glass chimnies cooling too rapidly when they are taken off.

30th September, 11 am.—Visited the

176. CLOCH

lighthouse belonging to the Cumbrae Trnst.

Catoptric, 9 reflectors.

No lightning conductors, no fog signals; only about 4 or 5 days fog in the year, about November. Breaks 20 chimnies a month.

Ventilation indifferent; obliged to keep door open, which causes a very unwholesome draft of air. The keeper had noticed that the Toward light since it had been made holophotal was much improved.

27th September 1859.—Mr. GLADSTONE visited the lighthouse on the

177. COVESEA SKERRIES—No. 122.

in the Moray Firth. It is a first-class Scotch light, fully provided and fitted up in the most approved manner. It has a revolving dioptric apparatus like that on the Skerry Vore. The astragals are upright, but properly placed. A description of course will be furnished by the Northern Board. The head keeper had gone into town, the second was on sick leave, so an occasional keeper was in charge, who seemed to know little about the lights: otherwise all seemed right. The fine large iron pile beacon on the Skerries was observed.

1st October. The

178. GARMOYLE

light on the Clyde was boarded, and it was discovered that Captain Ryder and Mr. Graves had been there the previous night. The keeper, who lives there with his wife, little son, dog, and cockatoo, said that he had had no relief whatever for the last 20 years. He has a boat. The lamp consists of a cistern with two arms placed at an angle, each provided with a straight wick. It does not swing, and hence on rough nights much oil is spilt and much smoke produced; even then, after a calm night, there were dark patches on the glass of the lantern. There are no reflectors or lenses.

The Garmoyle light has sometimes broken adrift. As coals were being taken in at the time no opinion could be formed of its general cleanliness or tidiness.

A gunner at Dumbarton Castle, two boatmen, and the commander of the "Neptune," Kilmun steamer, bore testimony to the general efficiency of the lights. They said they knew of no complaints, but acknowledged that the Cloch was much brighter than any of the Clyde lights.

VISIT TO GLASS WORKS, BIRMINGHAM.

Dec. 23rd.—The Commissioners visited the works of the Messrs. Chance. They were accompanied by Mr. James Chance, who has special charge of the light-house works, and Mr. Masselin, the engineer, a French gentleman. The glass is manufactured on the premises. Specimens were shown, and the whole process explained. The glass is of a very superior quality, and seemed quite equal in colour to any that has been seen at home or abroad. It was superior to a specimen of French glass shown by the Messrs. Chance, which had a decided blue or green tinge. The glass is made in covered instead of open pots, and improved glass it is hoped will be produced.

Besides clear glass, coloured glass of many shades is manufactured on the premises, where about 1,000 hands are employed.

The grinding of prisms and lenses is performed in a large building by the help of machinery of a superior description to any yet seen. The required curve on the reflecting surface is given by a rubber fixed at the end of an arm worked by steam power. Numerous contrivances have been introduced by Mr. James Chance, who took a high place as wrangler at Cambridge, who calculates all the angles, and seems fully to understand the requirements of the manufacture of lenses, a most difficult and complicated process.

Every lens and prism is tested when made, in a dark shed, with a very small gas flame placed in the assumed conjugate focus for the eye of an observer placed at a considerable distance outside in the other focus. The whole polygonal lens is in like manner tested when complete, and for that purpose it is fixed in a frame of brass. The Messrs. Chance consider that it is a mistake on the part of the Lighthouse Authorities to order the glass portion of a lens from one manufacturer, the brass work from a second, and the lantern which is to contain the lens, and the lamp which is to be used in it, from a third or fourth. They complain that they are not informed of the nature and size of the light which it is intended to place in the lens which they are instructed to make. They consider that the lens and all belonging to it should be constructed as a whole; and in this view the Commissioners agree, if any one manufacturer is able and willing to contract for all parts of the illuminating apparatus at a reasonable price. The Messrs. Chance state that they have not been allowed to tender for the brass work of the lenses manufactured by them, though they have been obliged to make brass work in order to test the lens before it left the premises, as the fixing of the prisms is very important; this complaint appears reasonable.

With reference to coloured glass, it was stated that particular shades have been tested; various shades were shown; the subject of placing panels with portions of the lenses complete, so as to alter the direction of a ray of light with reference to the horizon and the altitude of the light was discussed. Mr. Chance held that it was impossible to alter the optical properties of a lens when once ground by placing it in any position with reference to the light, except the one for which it was intended and made; but he admitted that which is equally clear that a great portion of the light produced is now thrown above the horizon, and the quantity lost is greater the greater the elevation of the light. The question of placing metal reflectors inside the glass of revolving lights on the side, which was not required, was also discussed. The engineer at first maintained that

Scotland.

Birmingham.

Mode of testing apparatus.

Direction of beam.

this could not be done, but on being shown how, admitted the practicability. Small reflectors are now placed close to the electric light at South Foreland, and work well. The subject of *casting* lenses was mentioned. Mr. Chance does not approve of the principle. It was decided by the Commission to examine Mr. Chance as a witness on some future occasion.

23rd March 1860.

Present: Admiral HAMILTON, Captain RYDER,
Mr. GRAVES, and Mr. GLADSTONE.

The Astronomer Royal called and conversed with the Commission on the subject of lighthouse apparatus. His views appeared to accord with those held by the Commission in many respects. It was proposed to visit a lighthouse for the purpose of testing the position of the lenses with reference to the horizon and the flame. Various plans for so testing the apparatus were discussed, including the erection of a mast outside the lighthouse, and various other schemes.

The drawings of Mr. Stevenson were shown to the Astronomer Royal, and he was informed of the observations made at Biarritz, and at some other places, with reference to the quantity of light now apparently lost on the sky.

3rd April.—The Secretary observed the

LIVERPOOL BUOYS

in Victoria Channel. The conical buoys were rocking very considerably though there was not much sea on.

The cones bent over till their sides were perpendicular, or rather overhanging the base; the Bell buoy rocked very much. Supposing the Bell buoy to be a model of one of the proposed light towers, the oscillation was much more than that of the mast of the lightship near it. Supposing the conical buoys to be the steadiest form of Herbert's principle, even then the oscillation of the top was more than that of the mast of the lightship, but then the sea was much heavier in proportion to the size of the buoys. On landing, inspected the lighthouse at

179. THE HEAD, DOUGLAS, ISLE OF MAN.

This is under the Commissioners for Northern Light-houses, and was handed over to them by the island authorities a short time ago. A new house for the keeper has been built.

The reflectors were in the usual good order, but the lamps were not so good, being the old lamps. The whole establishment bore the appearance of an old inferior light, handed over to better keeping, and in process of change. The communicating whistles had been introduced, and other changes were in progress. The head keeper subsequently stated, that when he first came, the reflectors were no better than those at the end of the Douglas Pier. That is very bad. Tried a large plano-convex lens in the place for the flame, and saw the horizon and a great deal of sky. Tried a smaller lens and saw no horizon, but all sky. It follows that the lower part of the flame is all reflected on the sky, though these reflectors have been set by the keeper with a slight downward inclination, and though it is only 104 feet above the sea level.

4th April.—Inspected the

180. PIER LIGHT AT DOUGLAS.

There is a good tower and an excellent lightroom.

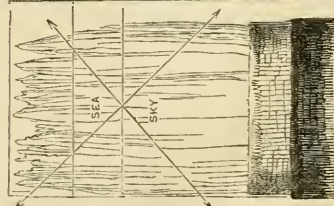
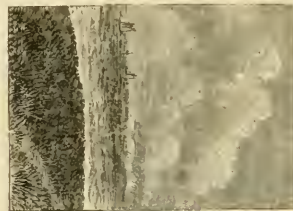
There are three large silvered reflectors with a bad surface. The light is produced in each reflector from three twisted cotton wicks placed in a square saucer of tin which goes through the back of the reflector, and is filled with oil. There is no glass chimney; in short the lamp is exactly the same as the common lamp hung in the poorest fisherman's cottage, and as old as the Italian tombs. The wicks were lighted and the three gave out clouds of dense black smoke. The whole building is as black as the inside of a chimney, and the old man who has managed this light for 40 years, stated that, on certain nights, the smoke is so dense inside the lantern that a man cannot be distinguished at a distance of three or four feet. The upper part of the reflectors were covered with a coat of soot a good half inch thick. The tin reservoir prevents the light from falling on the lower part of it; consequently the reflectors are almost useless.

The head keeper from the outer lighthouse attended, and stated that he could only see the light (distant about 400 yards) on windy nights, when the ventilation is best. A few pounds spent on three lamps to suit these three reflectors would make the light serviceable. Meantime it appears to be the very worst that has been seen by the Commission at home or abroad.

5th April.—Walked from Ramsey to the

181. POINT OF AYRE.—No. 84.

and inspected the lighthouse. It is a tower built in the middle of a sandy common, which has no road over it for the last mile or so. The keeper stated that it was very difficult to drive goods to the house. On one occasion the cart was upset, and a tram broken, and they had to gather up their provisions from a sand heap. The keeper states that there had been a great deal of correspondence on the subject of a road. Found the reflectors in very good condition. The lightroom well kept. There are four sets of lights, of three reflectors each; two sets being red. The colour is produced by the chimneys. Tried several plans for ascertaining whether the reflectors were properly placed, and whether the light of the lamp really falls in the largest proportion on the sea, or elsewhere. In the first place ascertained that all the lower tier of reflectors were placed on the same plane, by placing the head firmly against the glass of the lantern in such a position that the reflected image of one eye was seen in one reflector on the same level as the reflected image of the horizon. On making the machine revolve the horizon appeared as a continuous and nearly straight line in each successive reflector.



From the head of the lighthouse, looking down the pier, showing the lightroom and measurement.

Isle of Man.

Old apparatus.

Astronomer Royal.

Direction of beam.

Direction of beam.
Experiment.

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Direction of beam.

Experiment.
Hemispherical lens.

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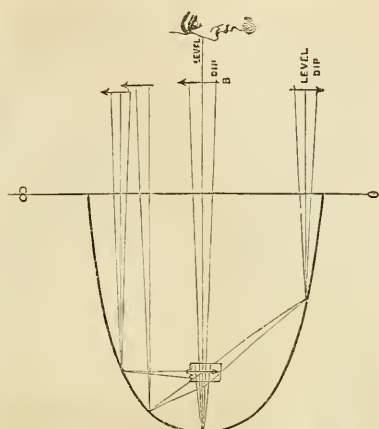
Vol. II. 338

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*Direction of
beam.*

*Experiment.
Hemispherical
lens.*

of Man.



Next placed two plano-convex lenses of different thicknesses on the lamp, flat side downwards, and found that no rays from the horizon fell on the thinner one. Next caused one of the lamps to be lighted, and cut out the size of the flame in thin paper; oiled that, and stuck it on to the glass chimney, and found that it entirely masked the flame from the back of the reflector; and then extinguished the lamp. Then turning the paper to the outer side, by turning the chimney, an inverted image of the horizon, and the landscape outside was formed on the paper; and the general position of the objects seen were marked on the paper with a pencil.

Now, as a ray of light proceeding from A to B follows the same course as a ray proceeding from B to A, whatever be the optical arrangement traversed, this experiment seems to show fairly what parts of the landscape are illuminated by the lamp, and the result is that of a piece of paper $2 \times 1\frac{1}{2}$ inches more than one-half, which answers to the lower half of the flame, was covered by the image of the sky, and of the remaining half fully two thirds were covered by the image of the ground near the lighthouse, so that of the light of two inches of flame only about one third of an inch was thrown on the sea by the reflector, and the lower and most luminous portions were reflected above the horizon on the sky.

The keeper stated that the light could be seen from the shore, that is, from one of the points seen on the paper inside.

As the light shines on hills also, it is in a peculiarly favourable position for proving the truth of the experiment. Accordingly sent for a lad at Ramsey, who had been up at Prince Albert's tower "at fire-work time," and who said he had seen the light from that station "sometimes in, sometimes out, going all round." Now, North Barroole is 1,850 feet high, and Albert Tower about two-thirds, say, 1,200 feet. It is, therefore, proved that the light, at the Point of Ayre, is *not* thrown in parallel beams on the horizon, but in widely diverging beams on the land, and on the sky, above and below the horizon, and that only a narrow band of the flame of each lamp is reflected on the sea where it is wanted.

The experiment, therefore, taken either way, is conclusive, and shows that only a very small portion of the light produced is used in the proper plane; and because the revolving light shows all round, so much of it as falls on the shore is wasted, even when it does fall on the proper plane.

Now, surely, there must be some optical arrangement by which this waste can be avoided. Taking a lamp shade as an illustration; it would be easy to prevent the light from falling on the upper half by simply placing a reflector round the central band where the sea image was formed parallel to the horizon.

That arrangement would prevent the light from being cast on the sky and mountains, and a further arrangement of cylindrical lenses would surely gather up the rays so as to fall on the sea; but at present it is quite certain that when the flame is too low, little or no light is thrown on the sea at all.

The keeper at Point of Ayre sees in fine weather Bahama Bank, St. Bees, Little Ross, Mull of Galloway, and mentions in his book at 9 p.m. whether he sees them or not.

6th April.—Inspected the harbour light at

182. RAMSEY.

The people had notice that the place was to be inspected; the floor was sanded, and the walls tolerably clean. The house is a tower of loose masonry on the end of the pier. It overhangs the base very considerably, and when the sea dashes against it, the water passes through the walls. The keeper has made a hole at the door for the water to run away. The light is produced by an Argand burner with a red chimney placed in the focus of a reflector, which is constructed of four tiers of bits of common looking-glass, set about a centre of the same material. In short, the same kind of reflector which was lately shown by Professor Faraday as a curiosity at his lecture, and is preserved in the museum of the French lighthouse authorities in Paris. The lamp and reflector are fastened to a bar of iron, and revolve about it for cleaning, but the bar slopes with the tower; the oil flows from the lamp when it is on the lower side, and it must flow unevenly when the reflector is in the proper position for showing the light. The keeper gets 6*l.* a year, and he or his wife is expected to visit the light three times on winter nights and twice in summer. He said there were complaints of the light, but there was no inducement to pay it attention. "The house was neither wind-tight nor water-tight." No other light is seen from the anchorage. The Point of Ayre is lost about two miles off, consequently this is an important light. The keeper complained that he had no means of cleaning the outside of the glass.

The man was so sunburnt that he did not look like a keeper who spends most of his time in a lightroom. And it subsequently appeared that he had just returned from a successful run on board some vessel. This light is neither well provided nor well cared for. Gas is laid on close to the lighthouse, but oil is used in the pier light.

7th April.—Inspected the harbour light at

183. PEEL.

It is a wooden building like a large sentry box, raised on four legs, about nine feet high, and placed on the end of the pier. A gas lamp stands close to it, and is masked from the sea. The boy who takes care of the light works in a saw mill. Found him, and was told that he got 6*l.* a year; as for the light, "he just lights it and leaves it."

He said that "the rain came through the house," and that "the wind blew through the ventilators." The illuminating apparatus consists of two Argand burners in the foci of two looking-glass reflectors, similar to the one at Ramsey; the light is shown through a window of common glass with small panes.

Anything like the filth of the whole place has not been seen anywhere by the Commission. The walls, the backs of the reflectors, the mirrors, and even the windows were covered with a mixture of grease and soot, the products of combustion, which had not even been wiped for a very long time.

The oil lay in a pool on the floor, and bits of old wick and scraps of dirt of every kind were littered about. Asked the boy if he spent much of his time in cleaning the place; said "he just lighted it and left it."

Walked to Port Erin and tried to get to the Calf

lighthouse, failed for want of a boat, staid for a long time at the Sound, but there was no one moving on the opposite side.

1st May.

Present: Admiral HAMILTON and Mr. GLADSTONE.

Ireland.

Colonel La Touche, a member of the Ballast Board, presented himself, and stated that a meeting of members of Parliament had signed a paper and passed a resolution as to the Ballast Board, and the refusal of the Board of Trade to sanction the expense of a steamboat, and that a question was to be asked of the Government in the House.

It appeared that the Ballast Board formerly had a steamer which cost 20,000*l.*, and which the Board of Trade obliged the Ballast Board to hand over to the Trinity House. That Board sold the steamer for 6,000*l.*, and she was engaged in carrying stores to the Crimea. She was subsequently sold to the Sultan for 20,000*l.*, and is now his yacht.

The Ballast Board are now obliged to borrow a steamer from the Trinity House, and the vessel which is lent to them is said to be unfit for the sea on the west coast of Ireland.

They are also obliged to send oil and stores to light-houses in sailing vessels, and the service often suffers from delay.

A case was mentioned in which the Ballast Board had been obliged to take a low offer in a contract for houses at Tuskar, and had subsequently been obliged to take the offer which they had originally wished to take, as the contractor reported that his estimate was erroneously made and too low.

18th April.

Present: Admiral HAMILTON, Mr. GRAVES, and Mr. GLADSTONE.

Special inspection.

The specifications of the Lighthouse Boards were looked over.

4th May.—Admiral Hamilton and Captain Ryder attended.

Astronomer Royal.

The Astronomer Royal looked over the specifications sent by the Trinity House and the Commissioners of Northern Lighthouses, and compared the drawings and lithographs. Secretary read the paper drawn up by him; showed part of the scientific returns; Mr. Chance's answer, &c.

8th May.—Admiral Hamilton, Capt. Ryder, Mr. Gladstone, and the Secretary, accompanied by the Astronomer Royal, proceeded by rail to Totness and drove to Tor Cross.

See woodcut.

The evening was wet, and a haze in the atmosphere. After dark observed the light on the Start Point distant four miles from the beach in front of the hotel. The revolving beam could be made out after it had passed, and showed in the haze somewhat like the tail of a comet.

From the sea the beam appeared to strike upwards, and it was determined to ascend the hill behind the inn, to observe whether the same appearance would continue, and to what elevation.

The light was observed from various points, and was clearly seen at the highest point reached. It appeared to strike upwards at first, then at right angles to the light tower, and finally downwards.

The point where the beam appeared to point downwards, was estimated to be higher than the light, and in daylight it appeared to be so.

The beam appeared to diverge. This observation confirms those previously made elsewhere, and proves that a considerable portion of this light is thrown on the sky, and lost to navigators.

9th May.—The same party visited the

184. START LIGHTHOUSE.—No. 144.

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The comparison of this light with foreign lights in the mariners' evidence is on the whole unfavourable to it. Of seventeen comparisons ten are unfavourable. It is marked 1st order dioptric, fixed *Mariners' Evidence.* and flashing, and the catoptric lights along the same coast are more favourably spoken of by the witnesses. One object of the visit then was to try to ascertain if any cause could be discovered in the lighthouse for the unfavourable notice of a first order dioptric light, which, in the opinion of the Commissioners, should in this position be of the very best description.

On entering the lantern, the cause was sufficiently evident, and the observations subsequently made confirmed the first impression.

The apparatus is on the same principle as that at Inch Keith in Scotland, and Biarritz in France. *Apparatus.*

The central band of revolving lenses consists of eight, which are "built up" on the plan originally designed.

The glass is green and full of flaws, the surfaces are not evenly ground, and the distance of the lenses from the central lamp varies considerably. The whole contrasts unfavourably with Lunly and similar modern lights.

The fixed light is produced by a series of small curved mirrors placed above the lenses, but there are no such mirrors below; and the light which falls in the direction of the land, is not used at all. On further investigation it appeared that the mirrors were intended to be set so as to cast parallel beams at right angles to the tower, and consequently the greater part of these beams must be thrown above the sea when the mirrors are so adjusted, but on examining them closely it was found that their positions varied materially, and that they varied from each other in their construction. On looking downwards on a large plano-convex lens placed on the burner, the mirrors could be seen reflected in the place of the light; and a reflected image was also seen of those parts of the landscape on which a beam of light, produced at the lamp, would fall, after it was reflected by each mirror.

It was apparent that in some the horizon was not seen at all; in some the image was all sky, in others all sea; and the place of the horizon varied sensibly when it was seen. So far then as the fixed light was concerned, the appearance observed from Tor Cross was explained. *Direction of beam; mirror.*

The fixed light was very faint on the beach. On ascending the hill it was lost altogether, because there are no mirrors at all in that direction.

Several attempts were made to obtain an image of the landscape from the lenses, at the place of the lamp, as was done at the Point of Ayre (see Isle of Man minute), and at last by the following arrangement an image was seen on paper. All the glasses *Lenses.* were taken out of a telescope, and a bit of oiled *Image of landscape.* paper tied over the end of one of the sliding tubes. The tubes were then drawn out so as to form a shade in front of the paper, and another behind it for the eye, and the telescope was placed on the burner with the paper screen in the place of the centre of the flame.

The lamp had been previously lit, the flame *Flame.* measured, and then extinguished, and from the experiment it appeared that of a small flame, less than one half on either side of the focal plane, throws light on the sea through the lenses, while more than one half shines on the sky; and that the revolving light seen by the mariner is mainly derived from the upper part of the third or central flame.

The fourth wick is not used, and the flame was

according to the regulations of the Trinity House (as stated by the keeper). *Special inspections.*

Further observations were made by the Astronomer Royal, of which he subsequently communicated an account to the Commission. *Astronomer Royal.*

Dr. Gladstone took notes of several matters, among which were the following :— *Notes by Dr. Gladstone.*

The lamp pedestal was not quite level. The outer flame was only 1 inch high, but the central flame rose to a height of 2'75 inches.

The panels bearing the lenses formed very nearly a circle; 0'2 inch being the utmost divergence; but the centre of this circle did not coincide with the centre of the lamp by 0'5 or 0'7 inch. The character of the several lenses is given in the following table :—

Panels.	Focus of lens.	Height of focus above burner.	Observations.	Frame vertical?
No. 1.	Bad, and behind lamp.	Inch. 1'8	Upper parts of annular segments very defective.	Yes.
No. 2.	Good - -	1'9	3rd segment has two different curvatures.	—
No. 3.	Good - -	1'8	Flattening in centre of lens	Yes.
No. 4.	- - - -	1'9	Very variable	No.
No. 5.	- - - -	1'7	5th segment has a better curvature than any other.	Yes.
No. 6.	Good - -	1'8	Central lens badly shaped.	—
No. 7.	In front of lamp.	1'7	2nd segment bad.	Yes.
No. 8.	Behind lamp	1'8	Knot in middle of lens	Yes.
			1st segment bad; the others fair.	

There are 133 mirrors arranged in 7 rows of 19 each. The keepers state that they readjust these twice a year; but the adjustment was so various that when looked at in a semispherical mirror placed on the burner some showed sea, some all sky, and others gave broken images. The annexed drawing of the appearance of six consecutive mirrors was made at the time. The shaded part represents the image of the sea, the light part that of the sky,



The chain for the revolving apparatus is a "Jack chain" not welded; it has broken several times.

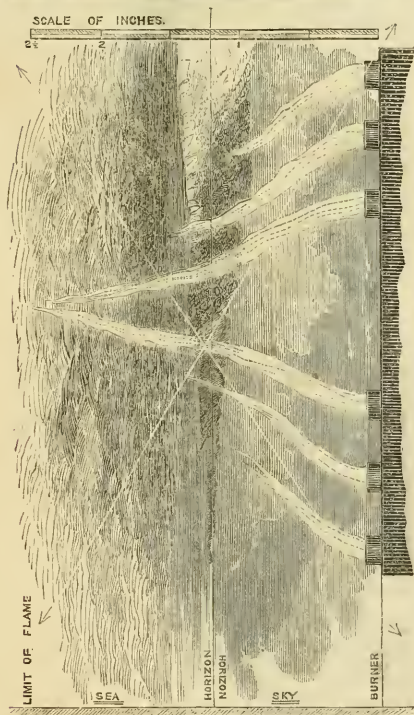
The result of the visit seemed to be that the evidence given by mariners is accounted for by the apparatus, and that the view previously taken is sanctioned by the authority of the Astronomer Royal, who was of opinion that the centre of the ray should be directed not above the horizon, but to some point within it. *Result.*

On leaving the lighthouse returned to Tor Cross and drove thence to Dartmouth.

Inspected a harbour light, 185. It is placed in a tower of some size, with a large plate glass window, the colour (red) is produced by a screen of red glass suspended in the window, the light is produced by the usual Argand lamp and silver reflector. There was no provision whatsoever for ventilation. *Dartmouth.*

The room was damp and the window fogged. The woman who keeps the light complained that she and all about her suffered from colds, and that the house leaked terribly. The roof is flat. There can be no doubt that the products of combustion account for a considerable part of the dampness.

May 10th.—Returned to London. Admiral Hamilton and Captain Ryder proceeded to the Channel Vol. II.' Islands, and were joined at Southampton by Mr. Graves. (See Remarks—Jersey and Guernsey.) 6 lights seen. 191.

Direction of
am.

Flame at the Start Lighthouse, and position of the inverted image formed by the lens appearance of the lighthouse beams.

according to the regulations of the Trinity House *Special inspections.*
(as stated by the keeper).

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No. 3.	Good - -	1'8	Flattening in centre of lens	Yes.
No. 4.	Good - -	1'9	Very variable	No.
No. 5.	- - - -	1'7	5th segment has a better curvature than any other.	Yes.
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Special inspections.

Admiralty—
Portsmouth.

May 31st.—Admiral Hamilton, Captain Ryder, Mr. Graves, and the Secretary went to Portsmouth, embarked on board the "Sprightly," and examined the buoys in the Solent under the management of the Admiralty.

On crossing one of the creeks near Portsmouth several boats used for the purpose of shooting wild fowl were observed from the train. They were painted white as a means of concealment.

On leaving Portsmouth it was remarked that all the buoys on one side of the channel were painted white, and the advantage gained by duck shooters was well exemplified by the extreme difficulty of distinguishing the white buoys on the water. Those on the other side were painted black, and were much more clearly seen. Those from which the white paint had peeled off, leaving brown patches, were better seen than those on which the paint was fresh.

On landing at Cowes, and questioning certain pilots they said, with reference to white buoys, "we cannot make them out, we never see them at night." The disadvantage of white on the water has been sufficiently proved elsewhere.

The buoys were all small, conical, and moored by the apex. It was stated that during the ebb, at spring tides, and with particular winds there, buoys go under water for a time.

A new buoy on Peacock's principle was being

placed at the Spit. The bell was sounding. The buoy was coloured black, it was lofty and clearly seen, but it was stated that a similar buoy moored outside the Needles had capsized frequently.

The Commissioners were unanimously of opinion that the buoyage of the Solent was inferior to that of Liverpool and the Downs, where the buoys are larger and more conspicuous, and where they are dark in colour.

The buoyage of Cowes harbour under a local authority was complained of by the pilots examined.

These witnesses said that a buoy was wanted at Peddleton Spit. That they were well acquainted with the Solent, and did not care much about the buoyage. They were satisfied with the New Trinity House light at the Needles, and generally considered the British lights superior to the French lights, which they frequently saw, but Southsea Castle light under the Admiralty they considered to be "a poor light," though they "did not look after it much."

The Commissioners returned to Portsmouth and then to London.

June 4th.—Admiral Hamilton and the Secretary proceeded to Dover. Embarked on board the "Vivid" at nightfall; steamed to Dungeness and towards

Colour of buoys.

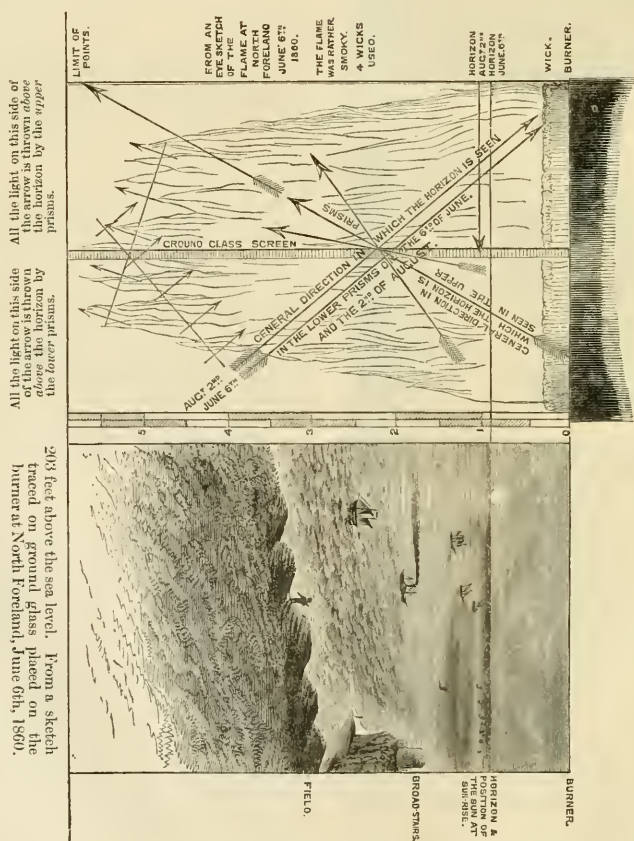
Oral evidence.

Buoys go under water.

North Foreland.

Lamp flame.

Inverted image formed by lens.



Special inspections.

*Admiralty—
Portsmouth.*

Vol. II. 289.

May 31st.—Admiral Hamilton, Captain Ryder, Mr. Graves, and the Secretary went to Portsmouth, embarked on board the "Sprightly," and examined the buoys in the Solent under the management of the Admiralty.

On crossing one of the creeks near Portsmouth several boats used for the purpose of shooting wild fowl were observed from the train. They were painted v

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North Foreland.

Lamp flame.

Inverted image
formed by lens.

Grisnez, and returned to harbour at about 2'30 in the morning.

Observed the

192, 193. SOUTH FORELAND

lights; remarked that the upper light appeared very inferior to the electric light which was seen there formerly.

The lower light has never been changed, and gives a standard of comparison. It was remarked that the upper light (dioptric) showed less well from the mouth of the harbour, but that as the vessel receded it seemed to become brighter as compared with the lower catoptric light.

It was assumed, therefore, that the flame is placed with reference to the refracting apparatus rather lower than it ought to be, as at the Start, or that the flame itself was rather too low.

cided with the image of the sea, and that very little *Special in-* of this light is needlessly thrown on the sky, except *spectations.* from the lower prisms, which should be raised a little to give their full effect. The lamp has four wicks, all used; it is a moderator, worked by a weight, and the flame produced was rather too high for the supply of air, for it smoked. The keeper said that he had not yet acquired the art of regulating it, and that he thought some change should be made in the shape of the chimney or that it should be lowered.

The part of the circle where light is not wanted is *Reflectors.* occupied by two large metal reflectors, these were found to reflect a large quantity of light to the place of the flame, but their form was rather irregular, still on placing the eye near the flame the whole surface of the reflector was seen brilliantly illuminated.

A narrow band of red glass placed outside the lens, *Red light.* causes the light to show red in a particular direction.

This apparatus appeared to be very well

My own plan. This was to have been executed in cloth, and pasted over the drawing at P. 53.



After some remembrance I was allowed to carry out my own convenience in my own way. I was the larger drawings at the end and the result.

Special inspections.

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Portsmouth.*

Vol. II. 289.

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194. DUNGENESS

was pronounced to be an inferior light; on passing near, it was observed that the light varied very perceptibly in various azimuths as the vessel passed the reflectors. This defect is inseparable from a fixed catoptric light on the present system, and does not exist in fixed dioptric lights.

The "Vivid's" head was then put in the direction of 195, Grisnez, and run on a direct course towards the light till Dungeness entirely dipped. This it did after running 14 miles, the precise distance given in the Admiralty directions as that at which Dungeness is visible. Grisnez came in sight at about five miles from Dungeness, distant about 18 miles. The night was not clear.

There could be no doubt that the light at Grisnez was more powerful and of a whiter colour than that at Dungeness. The same difference in colour was also remarked in the upper and lower lights at South Foreland. Grisnez is, however, a *revolving* light, and ought, therefore, to be more powerful than the South Foreland, which is *fixed* dioptric. The latter was more powerful and of a better colour than Dungeness, which is fixed catoptric. The position, therefore, of Grisnez, with reference to other lights, may account in some degree for the preference given to it over other foreign lights. It is the most powerful form of dioptric apparatus contrasted with less powerful dioptric apparatus, and with the least powerful form of catoptric apparatus placed at Dungeness.

Observed that the harbour lights at Dover were very bad.

June 5th.—Landed at Margate and drove to

196. THE NORTH FORELAND.—No. 29

to see the new apparatus lately erected. (For a description of the old apparatus, see page 33.) The new lantern has diagonal bars, and is a well executed work. The new apparatus is dioptric, first order, fixed, the brass work bright.

A square of ground glass cut to fit the supposed size of the flame, has been provided. It was placed in the centre of the burner, and it was ascertained that the image of the horizon, formed by the central band of lenses, occupied the same position all round. It was therefore proved that the lens was properly put together, and that it was set upright.

The place of the horizon and of the shore, and of objects visible at sea, were then marked on the ground glass with a pencil, and a drawing made. (See woodcut, page 48.)

The upper prisms were examined, and the appearance of the landscape noted, and it was seen that the greater part of each ring was occupied by an image of the sea. The lower prisms were also examined and it was found that in these very little was to be seen but sky.

The lamp was then lighted, and the appearance of the flame drawn on the ground glass. (See woodcut.)

It appeared that the best part of the flame coin-

I.

cided with the image of the sea, and that very little of this light is needlessly thrown on the sky, except from the lower prisms, which should be raised a little to give their full effect. The lamp has four wicks, all used; it is a moderator, worked by a weight, and the flame produced was rather too high for the supply of air, for it smoked. The keeper said that he had not yet acquired the art of regulating it, and that he thought some change should be made in the shape of the chimney or that it should be lowered.

The part of the circle where light is not wanted is occupied by two large metal reflectors, these were found to reflect a large quantity of light to the place of the flame, but their form was rather irregular, still on placing the eye near the flame the whole surface of the reflector was seen brilliantly illuminated.

A narrow band of red glass placed outside the lens, causes the light to show red in a particular direction.

This apparatus appeared to be very well constructed and arranged. The lamp requires attention, and some person acquainted with its working, should be sent to instruct the keepers in this and in all cases where any novelty is introduced.

It appeared as if this apparatus had been constructed on the usual plan, to throw a parallel beam from the centre of the flame at right angles, and the lamp raised so as to bring the horizon near the wick.

If this were done the light falling on the lower prisms would be thrown rather above the horizon, as was found to be the case. The same effect would also be produced on the light from the upper prisms, unless they were raised to suit the lamp, but it was not observed whether this had been done.

On returning to

197. MARGATE,

examined the harbour light, in charge of a local authority. It is in a lofty well built tower, and consists of three common batwing gas burners, without any attempt at reflection or refraction. The red colour is produced by placing some small panes of red glass loose in the window of the lantern. The light may serve the purpose of a harbour light, but it cannot be powerful.

Observed the buoys in the Thames and many floating lights, which appeared to be efficient but which contrasted most unfavourably with the small dioptric shore lights seen in France, which consume but a small quantity of oil. It was again remarked that experiments should be tried to apply the dioptric system to floating lights.

A hollow mast, like the funnel of a steamer, to act as light tower, and the lamp to be balanced as a compass is, or some such plan might be tried so as to preserve a constant level.

There do not seem to be any mechanical difficulties that could not be overcome.

June 6th.—Returned to London. The chairman and secretary called on the Astronomer Royal at the Observatory and showed him the sketch made at the North Foreland, and told him what had been done.

Secretary attended at the office; wrote minutes, and sent out correspondence; wrote to chairman suggesting certain points for the notice of Mr. Airy at the North Foreland.

The keeper at the North Foreland having been requested to make certain observations sent the following letter and a card, which was left with him for the purpose of making an experiment on the apparatus.

"GENTLEMEN,

"North Foreland Light,
"7th June 1860.

"In obedience to your instructions I beg respectfully to present the enclosed, the result of two observations of the sun at rising. Should further information be necessary, I shall be happy to give.

"I am, &c.

"(Signed) JAS. CHAPMAN, Keeper."

"To the Royal Lighthouse Commission."

The Secretary was directed to send cards and a letter to certain lighthouses.

G

Special inspections.

Reflectors.

Conclusions.

Thames buoy-
age.

Dioptric system
afloat.

Astronomer
Royal.

Experiment;
sunlight.

Wicks
Lucifer.

Vol. II. 305.

Vol. I. 33.

Vol. II. 79.

Apparatus.

Internal observation.

Lenticular
band.

Prisms.

Flame; woodcut.

Special Inspections.

A number of lighthouses were selected for their elevation, and cards were sent with the following letter accordingly.

"Royal Commission, Lights, Buoys, and Beacons,
"7, Millbank Street, S.W., London,

"11th June 1860.
"SIR, "I AM directed to request that shortly before sunrise or at sunset you will place one of the enclosed cards upright across the centre of the burner in the dioptric apparatus, so as to rest on the metal, and present one side to the point on the sea horizon where the sun rises or sets, as the case may be.

"In the case of a revolving apparatus one side of the lens must be set opposite to the point of sunrise or sunset, previous to making the observation.

"When the sun begins to appear above the horizon, or as it disappears, a bright light ought to appear on the card placed as directed.

"You are requested to mark on the card the exact position and form of that light.

"If the heat be so great as to scorch the paper so much the better.

"You are also requested to note whether similar bright lights appear in more places than one, either on the cards or on the metal work of the lamp, or elsewhere, at the time of the observation, and if so, you are requested to ascertain from what part of the apparatus these stray lights proceed.

"You are also requested to draw on another card the general form of the flame when at its usual height.

"It may be well to repeat the experiment at sunrise or at sunset on different days so as to check the observations.

"The object of the experiment is to ascertain the position of the dioptric apparatus with reference to the flame and the horizon, and to test the adjustment of the different parts of the apparatus.

"When the first experiment has been completed, on another morning or evening have the goodness to place another card at right angles to the position formerly occupied by the other, so that the light may fall on the edge of the card, and mark the direction of the lines of light which will appear on the sides of the card, and return the whole to me by post.

"I am, &c.

"J. F. CAMPELL,

"Secretary."

Lighthouses to which a copy of this letter was sent:

	Feet above the sea level.	By whom observed.
Dundrum Bay	- 62	
Scilly Bishops	- 110	Keeper.
North Ronaldshay	- 140	Keeper.
Skerry Vore	- 150	Keeper.
North Foreland	- 184	Observed; * Keeper's observation the same.
Calais	- 190	Observed.
Grisnez	- 194	Observed.
Start	- 204	Observed; and Keeper's the same.
Whitby	- 240	Observed.
Rathlin	- 244	Keeper.
Mine Head	- 285	Observed.
South Foreland	- 372	Observed.
Lundy	- 540	Keeper.

Result.

A number of these cards were subsequently returned, and from them, and from other observations made for and by the Commission, it appeared that the elevation of the light above the sea does not regulate the position of the lamp with reference to the image formed by the lens. The distance of the image of the horizon from the burner is the same by observation at South Foreland (372 feet above the sea) and at North Foreland (203 feet). At the Scilly Bishops (110 feet) the image of the sun was formed on the card rather higher

than in either. At North Ronaldshay (140 feet) it is rather lower. At Whitby (240 feet) the horizon was about the same as at North and South Foreland. At Grisnez (194 feet) the image is formed nearly half an inch higher than at Calais (190 feet). Skerry Vore (150 feet) and the Start (204 feet) are the same. Lundy (540 feet) is the lowest of all. The positions of the images formed by the reflecting prisms and mirrors were found to be equally various in the lighthouses where the experiment was tried by the Commissioners, and where the cards sent by the keeper's give information.

June 17th.—Admiral Hamilton and Mr. Gladstone, accompanied by the Astronomer Royal, went to Dover.

They visited the red and green harbour lights, and looked at them from distant parts of the harbour. The red appeared respectable; the green light was only distinguishable as the duller of the lights round the harbour, and by a greenish or blueish hue not very discernible.

June 18th.—Captain Ryder and the Secretary joined the other members of the Board and embarked for Calais.

With reference to the electric light, now removed, the captain of the steamer stated that he had often "carried the electric light of the Upper South Foreland Light into Calais harbour when he could not see the lower catoptric oil light at all."

In fogs he has seen the rays of the upper light when he could not see the light itself. "It shone on the sea near Dover;" the other, the oil light now used, does not shine on the sea nearly so much (that is to say, the divergence is less). The lower light does not shine on the sea near Dover at all.

198. CALAIS.

The Commissioners visited the lighthouse at Calais. The tower is a handsome building, the entrance paved with black and white marble slabs, forming patterns; and ornamented with busts of Fresnel and Beautemps Beaupré. All the metal work of the stairs was beautifully polished.

The tower has no floors, it is 57 metres high, and is ascended by a corkscrew stair. The keepers' room and the lightroom were well furnished, and the lantern surrounded with slabs of coloured marble, polished. The building in this respect is similar to the Tour de Baleine; and there is no lighthouse in the United Kingdom in which there is so much ornament.

The illuminating apparatus is dioptric, first order, fixed, with a flash, similar in plan to the small light at St. Sebastian in Spain. A fixed light apparatus with a series of three upright plano-cylindrical lenses, revolving outside. The effect is to produce a fixed steady light, of the full power attained by the use of such apparatus, darkened for a short period, and the dark interval succeeded by a brilliant flash.

The light was observed on the following evening from the South Foreland upper light, and was considered to be very powerful though less brilliant than the light at Grisnez, as seen from the same spot on the same night. The keeper at the South Foreland agreed in the opinion formed from this observation.

The same observation was made from Dover by the members of the Commission, and the same conclusion arrived at.

It was also remarked from Dover, that some of the flashes from Calais were brighter than others. (See letter from the Astronomer Royal on this point, dated June 25th, 1860, which contains his remarks as to the French trip, and account of his subsequent proceedings at North and South Foreland.)

The lantern bars are upright, so are the divisions in the bands of glass. There are mirrors on the land-ward side; but it was remarked that these were not so well polished as similar mirrors in England.

The lamp has four wicks. The whole was in remarkably good order. The keeper stated that he cleaned the glass apparatus with spirits of wine and chamois leather.

* OBSERVED BY PERSONS connected with the Commission, Astronomer Royal, &c.

This was entirely my own invention and was made and the Astronomer Royal had nothing to do with it but told it.

Direction of
Flame at North horizon
Flame at South horizon
Plane of observation
Griznez
Majority
Special Inspection
Observations by Dr. Gladstone

On examining the placing of the apparatus it
 Of the 12 lights compared with Griznez, 7 are
 ; worse ; Majority, 2 for British
 tions.

arisons, 18 are for Griznez, 30
 for British lights.

Commissioners started at 4 a.m.
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 at the Start; 16 faces of lenses
 mercurial curved glass mirrors
 slow; but inside the revolving
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 e reflectors are placed.

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 beam.
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 s on the sea.

l that he set them without any
 orizon itself; he also pointed out
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are intended by the inventor to conduct cold air to
 the lamp down the same chimney in which the column
 of hot air ascends.

The Commissioners were unable to ascertain that
 these currents were actually descending, and cannot

atches made by Dr. Gladstone at
 of the sea horizon as reflected
 Observations by
 Dr. Gladstone.

from the upper mirrors, generally cuts the flame
 in a plane considerably higher above the burner than
 was the case with the upper reflectors at Calais, and
 thus a larger quantity of light is thrown by them upon
 the sea, and, perhaps, also upon the horizon. Again,
 the image of the sea horizon as reflected from the

in an eye sketch. Proceed from
 measurement of the flame
 at.

Paris June 19 1860.

icks. used.

s. 830 grammes per hour.

il contrivance for.

invented by the
 light-keeper of the

The flame was
 remarkably steady.



Blue flame with streaks of white

Will

Special Inspections.

A number of lighthouses were selected for their elevation, and cards were sent with letter accordingly. At North Ronaldsay (110 fms)

"Royal Commission, Lights, Buoy

"7, Millbank Street, S.W.

"SIR,

"I AM directed to request the sunrise or at sunset you will place on cards upright across the centre of the dioptric apparatus, so as to rest on present one side to the point on the sea the sun rises or sets, as the case may

"In the case of a revolving apparatus the lens must be set opposite to the point sunset, previous to making the observation

"When the sun begins to appear above or as it disappears, a bright light on the card placed as directed.

"You are requested to mark on the position and form of that light.

"If the heat be so great as to see much the better.

"You are also requested to note bright lights appear in more places on the cards or on the metal work elsewhere, at the time of the observation you are requested to ascertain from the apparatus these stray lights proceed.

"You are also requested to draw on another card the general form of the flame when at its usual height.

"It may be well to repeat the experiment at sunrise or at sunset on different days so as to check the observations

Experiment, sunlight.

South point 872

540	Revolving
285	Revolving
192	Revolving
3	Revolving
36	Revolving
10	Revolving
18	Revolving
34	Revolving
10	Revolving
140	Revolving
48	Revolving
62	Revolving

In fogs he has seen the rays of the upper light when he could not see the light itself. "It shone on the sea near Dover;" the other, the oil light now used, does not shine on the sea nearly so much (that is to say, the divergence is less). The lower light does

204

184

North Ronaldsay (110 fms) Image of Sun (upper)

204

On examining the placing of the apparatus it appeared that the central bands and the upper prisms were well placed with reference to the light; but that nearly, if not quite all, the light reflected by the lower prisms is lost on the sky.

The Astronomer Royal was requested to report on this and the other lights visited.

In the evening the Commissioners returned, and the dimensions of the flame were accurately taken, with a view to comparison with flames elsewhere. It was better and steadier than any flame seen in England.

It was remarked that the lantern was surrounded with a net of wire, and its use was exemplified by a museum of stuffed birds, all of which had been caught, or had killed themselves at this light. These included many rare small birds; a bittern, some large cormorants, and a swan.

The keeper stated that he was occupied in cleaning the glass when the swan flew against the lantern, just above his head, it broke the glass, and injured the lens so much that it cost some 3,000 or 4,000 francs to repair the damage. The man considered that the force was sufficient to have killed him, if he had not been seated at his work.

The superintendent of the district, Monsieur de Lanois, accompanied the Commissioners in the evening and explained to them a system of ventilation of his own invention, which has been adopted in several French first-class lights. It consists of tubes, which are intended by the inventor to conduct cold air to the lamp down the same chimney in which the column of hot air ascends.

The Commissioners were unable to ascertain that these currents were actually descending, and cannot understand why they should, but the lamp certainly burned well and very steadily.

The two lights at the South Foreland were observed from the French coast that same evening; the upper one, that is the dioptric, was decidedly the brighter of the two. It was the opinion of the Commissioners that the Pointe de Walde light did not appear so bright, when viewed from Calais, as one of the 3rd order should have appeared.

199. WALDE.

On leaving Calais light in the morning, the Commissioners drove along the sand to the lighthouse at Walde. This is a pile light, similar in construction to the Maplin in the Thames,—iron piles on screws fixed in the sand. The illuminating apparatus is dioptric, third order, made of *cast glass* on the new principle of manufacture, tried here as an experiment.

The image of the landscape formed by this lens was inferior to the pictures formed by ground and polished lenses. Straight lines seemed crooked, the horizon indistinct, and generally the imperfect surfaces evident to the touch must produce much dispersion and loss of light.

200. GRISNEZ.

COMPARISON OF GRISNEZ, (which is mentioned by mariners, and compared oftener than any other foreign light,) with 12 British lights.

Name of Light.	Nature of Light.	Height in feet.	Miles visible.	Miles seen.	Miles unobscured.	Comparison.	Majority.
1. South Foreland	D. Fixed	372	25	40	41	11	10
2. Flamborough	C. Flash	103	19	32	32	11	1
3. Beachy Head	C. Flash	185	22	32	51	11	1
4. Start	D. Flash	204	19	18	47	11	1
5. Lindy	D. Flash	208	30	45	55	11	1
6. South Stack	C. Flash	201	19	11	24	11	1
7. Crozier	C. Flash	274	22	32	29	11	1
8. St. Agnes, Scilly	C. Flash	138	16	20	3	11	1
9. Lizard	C. Fixed	229	20	30	76	11	1
10. Calf of Man	C. Flash	575	24	42	21	11	1
11. Dungeness	C. Flash	92	14	11	12	11	1
12. North Foreland	C. Fixed	184	18	140	7	11	1
GRISNEZ	D. Flash	194	22	35	108	30	18

Of the 12 lights compared with Griznez, 7 are said to be better, 5 worse; Majority, 2 for British lights.

Of the 48 comparisons, 18 are for Griznez, 30 against, majority, 12 for British lights.

June 19th.—The Commissioners started at 4 a.m. and drove to Griznez. As this light has been much remarked by the mariners who have given evidence, and as it is so favourably compared with other foreign lights, it was important to discover if any reasons existed for the preference over other foreign lights.

It was found to consist of an apparatus of the same description as that at the Start; 16 faces of lenses revolving, 7 rows of mercurial curved glass mirrors above, and four below; but inside the revolving portion of the apparatus, and on the landward side two large metallic reflectors are placed.

On examining the position of the apparatus, the horizon was high, $1\frac{1}{2}$ inches; but on examining the mirrors they were all found to be set, so as to throw their reflected beams on the sea.

The keeper stated that he set them without any instrument, by the horizon itself; he also pointed out the height of the flame, which was about the same as that used at Calais.

According to sketches made by Dr. Gladstone at the time, the image of the sea horizon as reflected from the upper mirrors, generally cuts the flame in a plane considerably higher above the burner than was the case with the upper reflectors at Calais, and thus a larger quantity of light is thrown by them upon the sea, and, perhaps, also upon the horizon. Again, the image of the sea horizon, as reflected from the lower mirrors, generally cuts a very luminous portion of the flame, and does not impinge upon the burner itself, as was found to be the case in many other lighthouses. Thus both the upper and lower series of reflectors are most efficiently adjusted. The lamp also was found to be perfectly central; and the metallic reflectors were better polished than is usual in France. The lenses on the whole were well made, the annular segments especially being much better than at the Start.

The following are the dimensions of the image formed by the lens in the place of the flame. (See page 53. woodcut p. 53.) Focal length, three feet; horizon, $1\frac{1}{2}$ inches above the metal of the lamp, which corresponds with the brightest part of the Calais flame. A house at the edge of the cliff to the northward, 4 inches; the edge of the cliff to the westward, $8\frac{1}{2}$ inches; height of flame about 5 inches.

The reason therefore for the favourable mention of Griznez appears sufficiently manifest. The flame and the optical apparatus are properly set with reference to each other, and to the horizon; and the flame is of the right size for illuminating an angle extending from the horizon to within a short distance of the lighthouse.

Whereas at the Start the mirrors are set so as to throw nearly all their reflected light on the sky; there are no mirrors on the landward side, and the flame produced is so low that nearly the whole of it is thrown on the sky by the lenses.

The elevation of these two lights being the same within 10 feet, and their apparatus the same in principle, the comparison is unfavourable to the British light.

One of the keepers had been in the French navy, and was very proud of a Crimean English medal which he showed. Few birds are killed at this station, and there were no wire screens round the lantern.

Special Inspections. The Commissioners returned to Calais and thence to Dover. The Secretary drove to the

Vol. II. 79. 201. SOUTH FORELAND—No. 30

Woodcuts, page 53. and compared the position of the image formed by the lenses. (*See wood cuts on page opposite.*) The flame was also compared with the drawing made at Calais, and it was found to be less steady.

Flame. It had more sharp points; it was lower, and generally it appeared to be a worse flame; there are but three wicks used.

The observation made from the "Vivid" on the last occasion was accounted for, as also the remarks of the Captain of the Dover steamer.

Direction of beam. The sea near Dover is illuminated by the narrow points of the upper part of the flame, and the horizon and the parts of the sea near it, by the lower and brighter portions. No light at all falls on the sea below a point opposite to the base of the lower lighthouse; none at all at the edge of the cliff. The experiment inside was verified by walking to the two points last named.

Setting prisms. The keeper stated that the lower prisms had been carefully set to throw a level beam very lately, by placing a red ball of about an inch diameter on the lamp, and looking through each prism in turn along a spirit level outside till the ball was seen.

The result of this is, that the best of the light must be thrown here, as elsewhere, to the geometrical and not to the visible horizon, the elevation of the light being 372 feet, and the sea horizon distant 25 miles; the prisms are set to throw a beam from the place occupied by the red ball at a height of more than 700 feet *above* a vessel on the horizon, while the mirrors at Grismez are set by the keeper without any instrument, to throw their beams to the visible horizon itself, and on the sea below the horizon.

Divergence electric light. Now it is sufficiently evident that the flame placed in a dioptric apparatus of this size must be of certain dimensions to cover a certain portion of the sea, namely, about four inches, to reach in this case from the horizon (on which the electric light was seen from Boulogne) to near the place from which the electric light was seen from the Calais steamer. It was then sufficiently intense to cast a marked shadow on one hand from the other. It was also stated by the keeper that the electric light was not more than one eighth of an inch in length, and that half an inch from point to point of the carbons extinguished it. The light was equally well seen in all directions, so it could not have been placed out of the central focus, and it remained to be explained how it had been made visible over such an angle. It was previously remarked that two small mirrors were placed on either side of the light, ostensibly to clear the bars, but it seems that as these mirrors have a certain height as well as breadth, they and they only were the cause of this divergence.

Plane reflector experiment. To try this, a common mirror was placed behind the flame of the oil lamp, and the keeper was directed to slope it downwards and move it about. The result was as had been anticipated, that an observer placed in a field within fifty yards of the lighthouse saw a brilliant light from the lens and lower prisms, when he could before only see the stray light reflected on the roof of the lantern.

Astronomer Royal. July 5th.—Admiral Hamilton and Dr. Gladstone met at Macartney House, Blackheath, and were joined by the Astronomer Royal and Mr. Chance of Birmingham, who had previously met at the Observatory.

The Astronomer Royal stated that he had pointed out to Mr. Chance, the defects which he had observed in the illuminating apparatus at Whitby, and that he

and Mr. Chance were agreed as to the best method of remedying these defects, namely, by setting the lamp lower so as to suit the position of the prisms, which now throw their light too high, and then lowering the central band of the lens to suit the new position of the lamp, cutting off so much of the central band as may be necessary from the lower portion, and supplying the gap caused at its upper edge with a new zone if required.

On this point the letter of the Secretary to the *Mr. James Chance*, Chairman, of the 4th instant, was read to Mr. Chance, and he agreed that the suggestion therein contained was substantially the same in principle, and only varied from his proposal in the manner of accomplishing the object.

After some conversation with Mr. Chance, a letter *Meeting with Trinity House* was prepared, inviting the Elder Brethren to meet the Commissioners and others at the lighthouses at North Foreland and Whitby, on some day in next month.

July 9th.—Admiral Hamilton and Secretary. Letters sent to Trinity House, Ballast Board, Northern Lights Commissioners, and French Authorities.

Dr. Gladstone went down to Portsmouth. In the *Observations* evening he observed 182, the Warner from Southsea. *Dr. Gladstone* It was a very distinct light.

July 10.—Dr. Gladstone examined the light at the end of the pier at

202. RYDE.

It stands on a tall strong post, and consists of an oil lamp surrounded by a dioptric apparatus. The lamp has a large single wick, in the middle of which is a large button that rises as high as the bright portion of the flame, and must obstruct a great deal of light. The dioptric apparatus is a lenticular cylinder, with two segments above the central lens and two below it. It appeared well made, of good glass, and in good order. The lamp had not been cleaned since the previous night.

The light shows all round the horizon.

July 11th.—Dr. Gladstone visited the lighthouse at

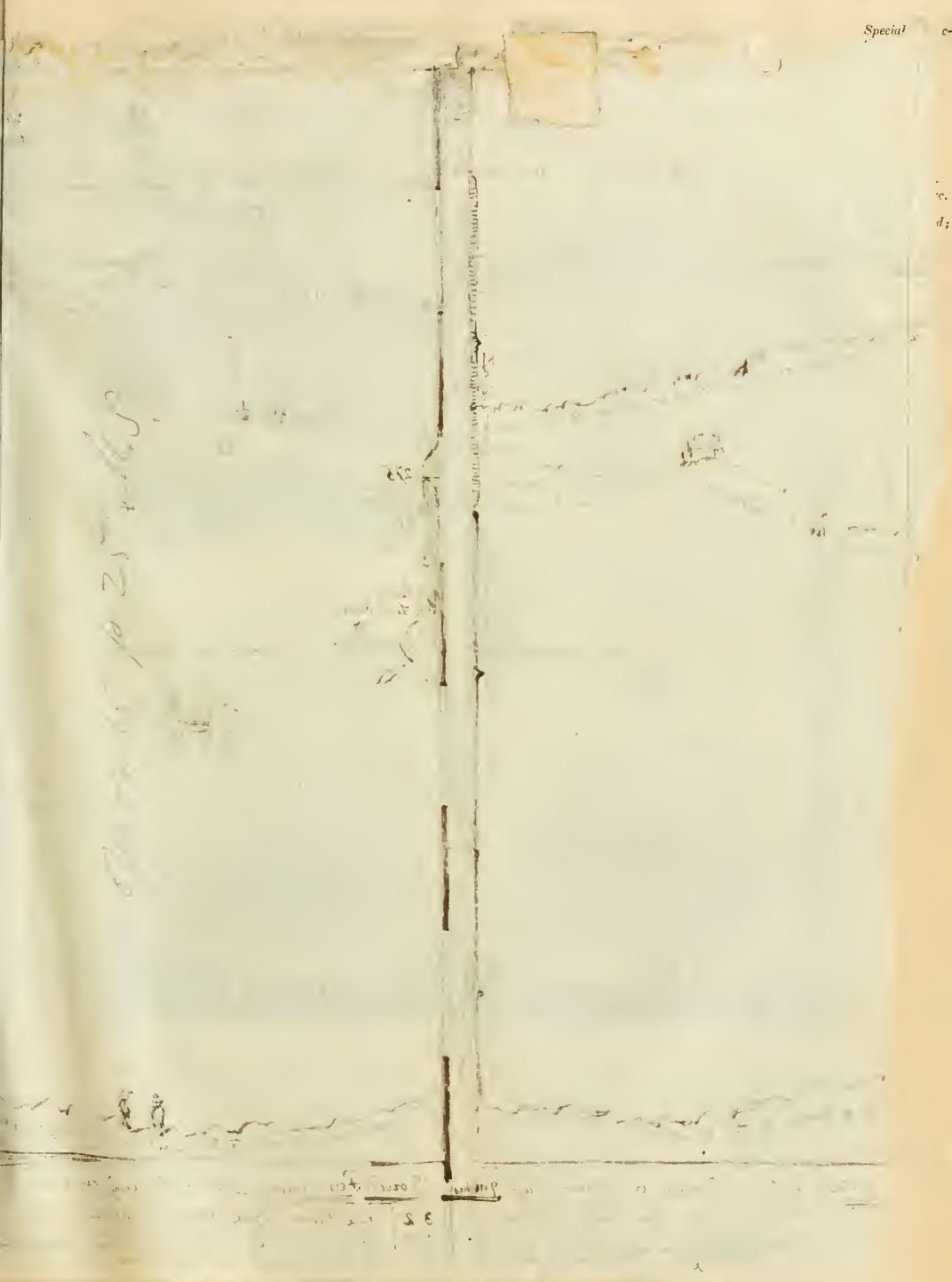
203. ST. CATHERINE'S HEAD.—No. 34. Vol. II. 81.

He confirmed the remarks of the Secretary made after his visit August 14th. In addition he paid particular attention to the illuminating apparatus and lamp. The apparatus bears the name of Wilkins, and the date 1840. The lenticular zones are of poor glass from Newcastle; the prismatic zones are of much better glass of French manufacture. The central bands bring the horizon of the sea to about 0.75 inch above the wicks of the lamp, but some of them bring it 1.1 inch above and others only 0.65 inch. The keeper stated very circumstantially the height of the flame as ordinarily burnt. The bright body of flame extends (he says) to a height of from $2\frac{1}{4}$ to $2\frac{1}{2}$ inches, and he raises or depresses the wicks till he obtains all the three circular flames of the same height, so that the flame is even at top instead of being tapering. By keeping the passages clean he prevents the formation of points of flame. The strongest part of the flame is stated by him to extend from half an inch above the wicks to $\frac{1}{2}$ inch. The lenses, therefore, are fairly placed, but some of the lenticular segments do not agree in focus with the central lens, and there are irregularities in their grinding.

In order to see the horizon in the lowest prismatic zone of the upper series, it was necessary to look two inches above the farther edge of the lamp; to see it in the second a smaller elevation was necessary, and so on, till with the seventh zone the horizon was seen in a line with the edge of the lamp, the line of the horizon as reflected from the six higher prisms cut

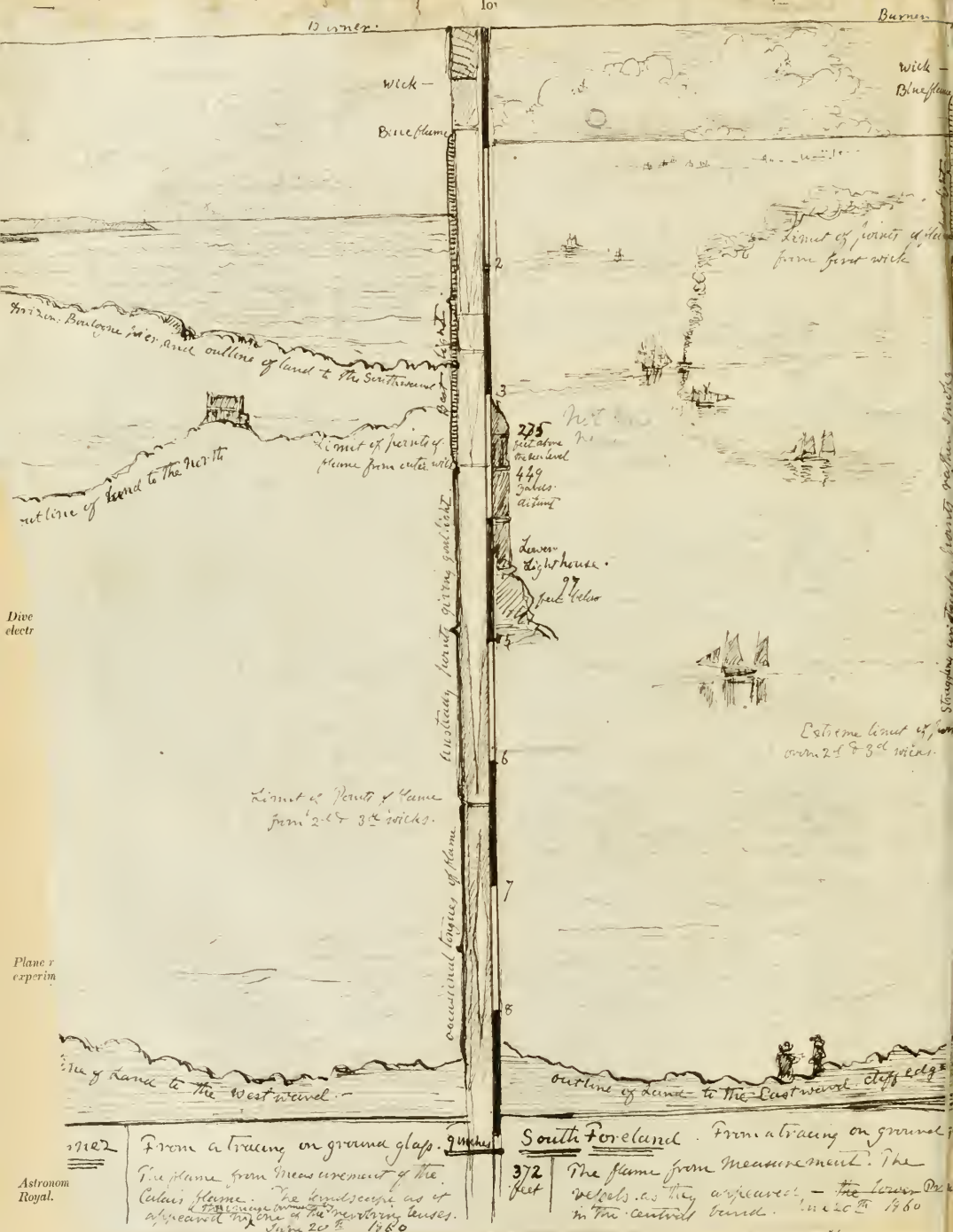
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Special



Special Inspectors. The Commissioners returned to Calais and thence to Dover. The Secretary drove to the

and Mr. Chance were agreed as to the best method of remedying these defects, and in setting the lamp



The Astronomer Royal stated that he had pointed out to Mr. Chance, the defects which he had observed in the illuminating apparatus at Whitby, and that he

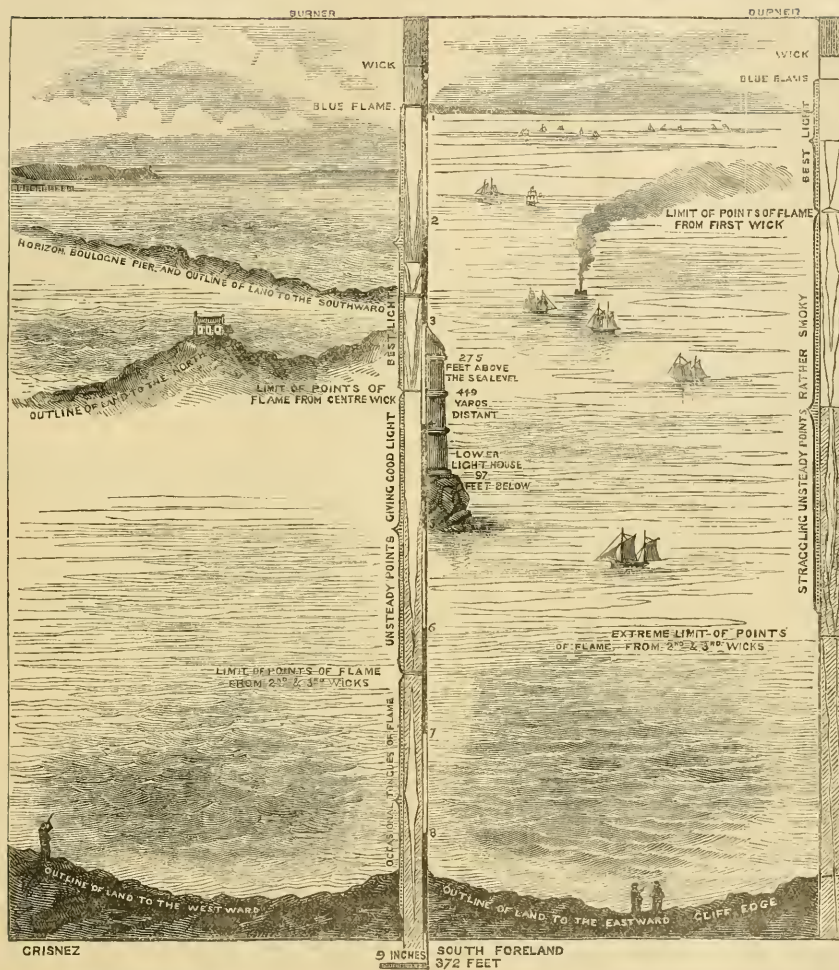
so on, till with the seventh zone the horizon was seen in a line with the edge of the lamp, the line of the horizon as reflected from the six higher prisms cut

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GRISNEZ.

SOUTH FORELAND

Flames, direction of beam, &c. Grisnez and South Foreland; Secretary.



From a tracing on ground glass. The flame from measurement of the Calais flame. The landscape as it appeared in the image formed by one of the revolving lenses. GRISNEZ. June 20th 1860.

From a tracing on ground glass. The flame from measurement. The vessels as they appeared in the central band. SOUTH FORELAND. June 20th 1860.

Special Inspections.

Observations by Dr. Gladstone.

the top of the lamp. From the lower series of prismatic zones the image of the horizon was only seen by glancing a little on one side of the nearer edge of the lamp; they were evidently, therefore, of little or no value for sending the light to the horizon or sea. The chief keeper (Mr. Cummins) had been a lamp maker before entering the service of the Trinity House. When first at the Eddystone he burnt three wicks, but the inner wick was afterwards discontinued, without, he thinks, a loss of light. The heat of the exterior wicks causes (he says) the inner wick to become gummy and thick, and sometimes to smoke. A button in the middle improves the combustion. He prefers a fountain lamp, such as he has, and never finds any practical difficulty with it, but in cold weather he wraps the pipe round with thick woollen cloth.

As the oil flows more or less freely, according to the temperature, he regulates by simple contrivances the height of the inner eistern, so as to give more or less pressure of oil. He prefers a lamp glass with a large open cylinder.

July 12th.—

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204. THE NEEDLES.—No. 35.

Lighthouse was visited. In addition to the remarks of the Secretary on August 15th, it may be recorded that the distinction between the red and white beams is made sharper by the placing of sheets of red glass (like horses' blinkers) at the junction of the two colours and radially to the lamp; nevertheless, the keeper has heard that in passing from the one beam into the other, an orange light is perceptible from on board ship. Three wicks are burnt, but orders have been given to burn four in future, but they have not been executed yet. The head-keeper, who was once assistant at St. Catherine's Head, considers the fountain lamp excellent if properly managed. He prefers a lamp glass with a square shoulder and a straight cylinder above. The illuminating apparatus is by Santer, and was erected in 1858.

The glass is very good, and the optical parts are very regularly made. The horizon is brought by the lenticular portions to 0.75 inch above the lamp, the flame extending, according to the keeper's statement, 2.5 or 3 inches with a good body of light. The upper series of prisms exhibits the same phenomena as that at St. Catherine's Head, but to a smaller extent, the line from the horizon as reflected, in most of them, cutting the lamp itself. The lower series also resembles that at St. Catherine's Head in its position with reference to the flame. Thus although this light is placed at no great distance above the sea level, the reflectors are so placed as to throw the light too high. During the first part of the visit the fog bell was being rung, but it required attention, as it stopped occasionally. The keeper said that some attempts had been made to set it right, but hitherto with only partial success; he sees the bell sometimes vibrate farther than at other times. It ought to ring for an hour and a half without being touched. The keeper said there was much fog about the present position of the lighthouse, but far less than on the cliff where the previous house stood; indeed, he has known a dense fog to last there for three weeks. There was one enveloping the upper part at the time when the above statement was made.

Fog.

Oxyhydrogen light.

July 16th.—Dr. Gladstone had a long conversation with Dr. Leeson of Bonchurch, on the oxy-hydrogen light, lamp chimneys, coloured flames, and other matters, which he promised to embody in a reply to the scientific questions.

July 18th.—The light on Ryde Pier was observed by night. It appeared very brilliant as seen from different parts of the town. The Warner lightvessel was showing a very bright light as compared with gas lamps that were comparatively very near at hand, and its periodic waxing and waning was very distinctive. The Southsea Castle Light was showing a

Southsea Castle

green light to all parts of Ryde, easily distinguished from the white lights on the same coast by its colour, but it was little (if any) brighter than some of the gas lamps on Southsea Common, and far less bright than the two large gas lamps at Portsmouth Pier, although it is rather nearer to Ryde than those with which it was compared.

The bnoys between Ryde and Portsmouth were observed. There was one of a conical form, on the top of which was something in printing characters. It was evidently supposed that it would lie somewhat on one side, indeed it was painted with that view, and thus the writing would be seen; but on the contrary, the buoy was riding with its apex perpendicularly downwards, and the inscription was only legible from the sky.

Defective buoys.

July 30th.—Present: Admiral HAMILTON, Captain RYDER, MR. GLADSTONE, and MR. DUNBAR.

First meeting with the Trinity House.

A deputation of the Elder Brethren, accompanied by Professor Faraday, met the Commissioners at 7, Millbank Street, and heard from the Astronomer Royal a statement of his observations made at various lighthouses, which he had visited at the request of Commissioners.

This statement was intended to inform the gentlemen present of the points which were to be explained more fully at the North Foreland Lighthouse on the 2nd, and at Whitby on the 9th August. The meeting was summoned in order to inform the Elder Brethren, and their scientific adviser, of these points so that they might have time for preliminary consideration of the subject.

Additional Observations of Dr. Gladstone on matters under the charge of the Trinity House.

August 1st.—Visited the Trinity House at Tower Hill, and steamed from Blackwall to Ramsgate in company with the Deputy Master and Captains Bayly, Close, and Webber, in the yacht Irene. This vessel is intended for a swift seagoing boat, as it is one of the duties of the Trinity House to accompany Her Majesty when afloat. The "Irene" is the vessel intended for this service, and has nearly the speed of the Royal Yacht. Her lines are said to be the same as those of the "Vivid," and she bears a close general resemblance to that vessel. She is comfortably fitted up. Beside the service above mentioned, and her use on special missions of the Trinity Board, she is ordinarily employed in making inspections and carrying stores or buoys to their destination. She had in fact returned from such a trip only the night before.

She generally carries two spare buoys, that if in the course of any voyage it be heard that a buoy is wanting on any station it may be immediately supplied. One of these is a wreck buoy, the other is of the ordinary form, and is intended for replacing one that may have gone astray, the proper marking of the missing buoy being imitated on a painted canvas cover, which is drawn over the substitute, and remains on it till the duplicate buoy can be sent from the store.

Visited the

204. MUCKING.—No. 28.

Light. This is built on piles in the river, but communicates with the bank by means of a bridge. The edifice is small, and not intended for living in, the dwelling houses being on land, which however is now considered an unfortunate arrangement, as the keepers and their families suffer much from the fever and ague commonly prevalent there.

The source of illumination is a fountain lamp, with two wicks. The illuminating apparatus consists of lenticular bands, without prismatic or any other reflectors. A great deal of the light is therefore lost. The glass and workmanship appeared good, and so

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was the adjustment of the lenses, the water line of the opposite bank of the river cutting the flame 0·8 inch above the lamp.

The light shows red up and down the river, but white to passing vessels. In the white portion however there is a red beam to mark a buoy.

The fog bell was sounded, but did not work satisfactorily.

The edifice was being painted at the time of the visit, white with broad black stripes, which caught the eye well.

Many observations were made in passing on

BUOYS IN THE THAMES, and at its Mouth.

One of Herbert's construction was noticed to be lying over very much on one side. This was believed to be from want of breadth at the bottom, as it was one which had been made out of a buoy of the ordinary form.

Other Herbert's buoys stood up well, for instance that in the West Oaze.

Some very strong Poulter's buoys were observed at stations where, as at the Shivering sand, they are very apt to be run into. In this instance the spherical device at the top was made, not of thin pieces of wood arranged as the circumference of a globe, but of stout planks in the form of half segments of circles placed radially, and capable of standing a hard blow. These buoys were very steady, having a broad base, but it must be borne in mind that they were observed on a calm day.

Some hollow pile beacons were passed. These had been driven into the ground by atmospheric pressure. They were very conspicuous. It was related that a similar one was erected on the Goodwin Sands, being sunk till it reached the chalk, and thus a permanent foundation was obtained.

On passing the North Foreland Lighthouse a little while before sunset, it was remarked that it could scarcely be distinguished from the grey sky.

Saw South Sand Head and the Gull Lights burning in the distance.

Recent experiments on the firing of guns at Holyhead, the comfort of keepers' houses, the peculiar position of the men at the Seven Stones in this respect, and other matters, formed subjects of conversation.

MEETINGS AT NORTH FORELAND AND WHITBY.

August 2nd.—Admiral Hamilton, Mr. Gladstone, Captain Ryder, and the Secretary, met at the

207. NORTH FORELAND—No. 29.

Lighthouse. They were accompanied by the Astronomer Royal. They were met by a deputation of the Elder Brethren of the Trinity House, consisting of the Deputy Master, Admiral Gordon, Captain Bayly, Captain Close, and Captain Weller, who were accompanied by their scientific adviser Professor Faraday.

They were met by Mr. Thomas Stevenson, who attended on the part of the Commissioners of Northern Lighthouses; by Sir James Dombrain, Captain Roberts, and Mr. Halpin, who attended on the part of the Ballast Board of Dublin; by Monsieur Sautter, the maker of the optical portion of the apparatus, who had come from Paris; and by Mr. James Chance, the maker of the optical portion of the apparatus at Whitby, who came from Birmingham, and by Mr. Wilkins.

The Astronomer Royal pointed out to the gentlemen present the defects which he had observed, the lamp being lit, and as many of the party as possible being within the optical apparatus, and in the lantern, where they could best hear what was said.

The lamp was subsequently extinguished, and the burner removed, two cross strings were fixed in the apparatus to indicate its centre, and a wire placed on the axis of the instrument. Monsieur Sautter proceeded to show the method which he considered to be effectual for exhibiting the qualities of his apparatus,

and contended that it was properly and accurately placed, so that the best part of the flame illuminated the horizon. *Special Inspections.*

The burner was then replaced, and it was remarked that the position of the horizon seemed to vary from that formerly observed. Mr. Wilkins stated that the lamp had been lowered one eighth of an inch within the last three days. The distance from the horizon of the image formed in the place of the flame to the brass work of the apparatus was measured on a bit of ground glass, and compared with the drawing made on a previous occasion, and the card sent by the keeper at the request of the Commission, which shows the place of the sun at sunrise to correspond with the position of the horizon as marked in the drawing. The difference between the present and the former position of the burner, according to these observations, was found to correspond with the statement of Mr. Wilkins.

The effect of the change made is to improve the position of the lamp with reference to the prisms, and to injure it in a corresponding degree with reference to the lens, but as the flame at this lighthouse has a considerable height, this alteration does not materially affect the amount of light thrown by the lens on the horizon.

The question then for consideration is, if any, or what alteration should be made in this apparatus as now placed.

Whether to lower the lamp still more, so as to throw the light from the prisms still lower, and to lower the lens till it occupies its former position with reference to the flame, or to raise the lamp to its former position, and alter the prisms as suggested by Monsieur Sautter, or to make some other alteration, or to leave the apparatus as it is.

It was remarked that the shoulder of this chimney produced a dark line in the light of the lamp, as viewed from outside the apparatus corresponding exactly to the image of the horizon. *Angular shoulder of chimney.*

August 3d.—Admiral Hamilton, Captain Ryder, and Dr. Gladstone met and talked over the proceedings of the previous day.

Capt. Ryder.

Captain Ryder read a paper in which he had entered what he had gathered as the views of the different persons who had spoken yesterday, in which the questions now before the Commission, and for future consideration, were stated very clearly. The paper contained diagrams, and the writer argued that the most important question was, "What are the most brilliant parts of a lighthouse flame of the best description?" in order that the point may be settled before it is decided, what is the best position of the lenses and prism with reference to the flame.

Photographs.

Dr. Gladstone was requested to consider what were the best steps to be taken to decide this question, and the photographs of lamp flames already made by the Secretary were looked at. He was requested to make photographs of a lighthouse flame at various other angles of vision, so as to experimentalize on the various angles of flame presented to the surfaces of the upper and lower prisms and the lenses, and for this purpose to proceed with Dr. Gladstone to make the experiment accordingly.

August 7th.—The Secretary made certain photographs of a lamp at the establishment of Mr. Wilkins, which he printed on the 8th, and showed at Whitby on the same day.

See Drawing No. 2, at the end of this volume.

August 8th.—Admiral Hamilton and the Secretary went to

208, 209. WHITEBY,—No. 6, 7

WHITBY.

and met Professor Faraday at York. The minute of the observation made at the Point of Ayre, on the image formed by a reflector, was read to Professor Faraday, as also the minute of the visit to the North Foreland.

The drawings made at the North and South Foreland and at Grimsby were also shown to the Professor, and sundry photographs.

Page 49, 53.

Special Inspections.

Page 78.

On arriving at Whitby, Professor Faraday, accompanied by the Secretary and Mr. Halpin, visited the two lighthouses, made such observations as could be made in the short time available at the north lighthouse, and examined the lamps at both, after they were lit.

The general impression arrived at seemed to be that the account given by the Astronomer Royal in his letter to the Chairman was confirmed by these observations.

Professor Faraday will in all probability report his views on this subject to the Elder Brethren of the Trinity House.

August 9th.—Admiral Hamilton, Captain Ryder, and Dr. Gladstone visited the lighthouses.

Mr. Graves was prevented from meeting the Commissioners, and telegraphed to explain the cause.

The Deputy Master of the Trinity House, Captain Close, Captain Bayly, and Captain Nesbit, accompanied by Professor Faraday met the Commission.

Mr. Stevenson and Mr. Halpin were also present, as well as Mr. James Chance, the maker of the apparatus, Monsieur Maselin (his assistant), and Monsieur Sautter from Paris.

Monsieur Sautter produced certain photographs of a lamp flame which he had executed since the meeting on the 2d, and was so kind as to present a copy to the Secretary for the Commission.

The Secretary in return presented to Monsieur Sautter a copy of those taken by him on the previous day.

Dr. Gladstone on the part of the Commissioners pointed out what appeared to be the defects in the lighthouse apparatus, and his account of the meeting is subjoined.

It appeared in the north lighthouse—

- 1st. That the lamp flame was inferior to others seen elsewhere, though much better than some.
- 2d. That the lamp was slightly, about one quarter of an inch, out of place.
- 3d. That the whole apparatus sloped towards the sea, which defect is in favour of the prisms.
- 4th. That there are no mirrors on the landward side, and, consequently, that about one half of the light produced is lost entirely.
- 5th. That the image of the horizon is formed a little too high by the refracting bands, but not in such a degree as to make the defect important; especially if a better flame were introduced.
- 6th. That the image of the horizon formed by the upper prisms, falls rather too far forward, but not in such a degree as to make the light inefficient at a distance.
- 7th. That the image of the horizon formed by the lower prism falls too low; below the edge of the burner, so as to throw nearly, if not quite, all the light which falls to the lower prisms upwards above the horizon, except in the direction of the other lighthouse, where there is a short panel in which the prisms are generally well adjusted, though not all.
- 8th. That the metal chimney above the flame is too short below the first opening, because on stopping that opening and altering the damper, the flame was very much improved.
- 9th. That the form of the chimney was very defective, in that it has a sharp shoulder, which materially interferes with the direction of the light.

It appeared to some of the gentlemen present that in spite of the observations made from within, light would in reality be seen in all parts of the apparatus from the sea. It was decided to test that point by the manner proposed by Captain Ryder.

The keeper was instructed to cover up the refracting band at a preconceived signal, and on returning to Whitby the party embarked on board the Trinity House Yacht, and proceeded to sea. On covering

the lens it was manifest that no light radiating directly from the lamp was to be seen in the lower prisms, but that a weak reflected light, that from the inside of the lantern or from some other source was barely seen through a telescope.

It appeared to some of the gentlemen that the light would be seen at a greater distance, the vessel therefore ran some distance to sea, when the experiment was repeated, and with the same result.

It appeared then to be proved that the observations made from within were confirmed by those made from without.

Where the light had appeared to be thrown too high it was found to be invisible from the sea.

Where it appeared to be properly directed, it was seen from a distance.

South lighthouse.

Similar observations were made inside. See Dr. Gladstone's remarks.

It was observed from the sea that the light did not appear as a continuous line when viewed through the telescope, but as a broken line, proving that some parts of the apparatus are not properly set for the existing lamp.

The Chairman requested Mr. Chance to write to the Trinity House, suggesting the alterations which, as he thinks, should be made in this apparatus.

Professor Faraday will make his report to the Trinity House, and it is proposed to request that copies of these documents may be furnished to the Commissioners.

The Secretary made several photographs from various points to illustrate the proceedings, one from a point between the lighthouses and below them, to show the general position; one of the south lighthouse, from the gallery of the northern lighthouse, showing the horizon, and, consequently, the angle of dip.

It was subsequently found that on looking from the other lighthouse, the horizon occupied the same position with reference to the northern lighthouse, and that both are on the same level.

Another photograph was taken from the gallery to show the angle filled by the image of the sea.

And two were taken from the inside, in which the flame and the image of the horizon coincident with it could be traced, and their respective positions determined.

So far it is proved, therefore, that, under favourable circumstances, the position of the image in the lamp flame can be photographically determined at one observation.

191. One of the harbour lights at Whitby was visited. There are three reflectors placed in a tower with gas-light flames.

The chimneys are of green glass and peculiar in their form.

The effect of the bulging shoulder, though good as regards the transmission of the rays, is bad as regards the production of light. The lights from the sea both showed green, and appeared efficient, but the polish of the reflector in this, as in other cases, was inferior to that of reflectors in Trinity House, and similar lighthouses.

The following is the account of Dr. Gladstone:—

Having discussed some optical questions, and the Astronomer Royal's letter relating to the Whitby lights, the party proceeded to the lights in question. These are set on two white towers, with the usual dwellings on a cliff; they are of the same altitude, viz. 240 feet above the sea level, and are 258 yards apart. The northern tower was first entered. The illuminating apparatus was found to be first class catadioptric, illuminating rather more than half the circle, without mirrors at the back, manufactured by Messrs. Chance.

Mr. Maselin, who had superintended the fixing of the apparatus on the site, tested the position of the lamp by means of the cross string, and found it one

See drawings, Vol. I. and Vol. II. 625.

Dr. Gladstone's account.

External observation.

eighth of an inch too high, according to Fresnel's rule, and only one sixteenth of an inch out of the centre. From the interior of the apparatus Dr. Gladstone then examined the relation of the different parts to the horizon and sea, and explained to the Deputy Master, Professor Faraday, Mr. Stevenson, and others what were considered to be errors of adjustment. The line of the horizon, as seen through the central lenticular zones comes just one inch above the lamp in the case of three of the panels, but 1·3 inch in a small panel to the south, and as high as 1·4 inch in the remaining panel.

There was no apparent cause for this discrepancy in the setting, nor could Mr. Masselin offer any explanation. The upper and lower lenticular segments generally agreed tolerably closely with the central lens of the same panel, but in some instances they differed widely.

When the lamp was lighted subsequently, its flame was found to be good for a height of about two inches, so that only three of the panels were well set for it, and had it been one eighth of an inch lower (according to Fresnel's rule) so much good light would have been lost, while even, as at present fixed, the lenticular zones could send little light to a steamer that happened to be passing at some distance and gave an image three inches above the lamp, or to smaller vessels that were still nearer to the shore.

Of the upper series of prisms the lower reflectors were evidently adjusted for the focal planes decided on by Fresnel, but the highest three or four directed their light too much towards the sky. Of the lower series of prisms, the reflectors had their focal planes so low that nothing but sky was seen in them through the place where the main body of flame is. It was difficult to determine the position of the foci of these reflectors on account of the irregularity of the curved surfaces, and the numerous striae in the glass.

The colour of the glass was considered very good, but it did not appear to be so free from blemishes as the French. The astragals of the lantern are slanting, but those of the apparatus itself are vertical.

The party then proceeded to the southern tower, and found the arrangements of the lantern and apparatus similar to those already described, with the addition of silvered reflectors on the land side, which showed a good polish. The line of the horizon in the central lenses, instead of being 1·1 inch above the lamp, as Fresnel desires, varied in the five panels from 1·4 to 1·5 inch, while the image of a passing ship came 3·2 inch above the lamp. To increase the mischievous action of this adjustment, it is the square shoulder of the lamp glass that is traversed by the horizontal line, and the lamp gives a singularly poor flame. The keeper termed it a 2½ inch flame, but he reckoned from the metal to the tips of the points. Reckoning from the commencement of the yellow part, which was 0·5 of an inch above the metal, to the top of the undivided luminous mass, it only amounted to 1·0 inch, and scarcely that for the outer ring; so that in reality the sea, even at the horizon, was being illuminated only by the irregular tongues of flame, as far at least as the central lenticular bands are concerned. When the flame was improved (as will be presently described), the body of flame reached scarcely two inches above the metal lamp, and the tongues rose at the highest to 3·5 inches, so that even then the best part of the light was lost. The remarks made on the prismatic zones of the other lighthouse apply equally in this case.

The lamp, as in the other house, has three wicks. It is not considered an overflow lamp; nevertheless, there is an overflow of about one fourth of the oil consumed. M. Sautter stated the French practice to be to cause three or four times the amount of oil actually burnt to overflow. The lamp glass expanded very perceptibly from the bottom to the shoulder, which was nearly square. When placed in position

with its top entering the iron chimney it could not be made perpendicular. There was an opening and deflector in the iron chimney at the height of 2 feet 11 inches, another at the height of 6 feet, and a third still higher. In order to test the effect of a longer continuous chimney, Professor Faraday covered the lower opening with paper, which instantly produced more draft, evidencing itself by a depression and a greater whiteness of the flame. By turning up the wicks and regulating the damper, it was now found that a considerably higher flame could be maintained. On removing the paper, this flame started up into long yellow smoky peaks, showing that more oil was being supplied than could then be completely consumed. When the six feet continuous chimney was lengthened by covering the opening at that altitude also, a further improvement of the flame, slight indeed, but evident, was effected.

During the course of this experiment it had been discovered by looking from the gallery and adjoining buildings, that a good light was shining from the lamp in the northern tower, through the lower reflectors in the direction of the horizon, and a better light still in the direction of the sea, while little light was proceeding towards the sky. Before going to the northern lighthouse to ascertain the cause of this, Dr. Gladstone re-entered the lantern, and observed the image of the northern tower in the lower series of reflectors through the flame then burning. In the lowest reflector the gallery was just visible; in the second and third from the bottom, the middle of the lantern; and in the fourth and fifth the upper part of it, while the sixth and highest was obscured by a bar. The party then returned to the northern tower, and found that the small panel of lower reflectors, through which the light had been seen from the southern tower, is adjusted differently to the others, and has, in fact, its focal planes in the anterior portion of the flame.

When standing on the gallery of this tower, a little light could be seen in the lowest reflector of the lower series of the southern lighthouse; on ascending a ladder it became more luminous, and as the ascent was continued, light made its appearance successively in the second, third, fourth, and fifth reflectors; and at the top of the tower the fifth was the most luminous of all. Thus, in both these instances, the practical test confirmed the observations made within the lantern, and showed that the panel of lower prisms was in the one instance set in such a manner as to be of great service, and in the other so as to be useless.

On attempting to rotate the apparatus in the north tower, it was found that it had become fixed by the sinking of the whole table on one side, caused, no doubt, by the optical apparatus pressing with nearly all its weight on that half of the table.

Mr. Chance undertook to suggest to the Commission such means as, on full consideration, should appear to him the most feasible for correcting these errors of adjustment.

In the evening the Commissioners and others of the party were received on board the "Irene," and steamed past the sunken reef, which is marked by the two lights being in one, and within which the northern light shines red. As they advanced towards the front of the cliff on which the lights stand, they observed that the northern maintained, except for a minute or two, a very decided superiority over the southern light. At a preconcerted signal from the yacht, the keeper in the northern house covered up the lenticular portion of his apparatus, when a great diminution of light was manifest, and the telescope revealed that whilst copious rays were proceeding from the upper series of reflectors, a very faint light was alone visible in the lower series. The steamer then proceeded to a distance of what was estimated by the commander to be between four and five miles from the shore, when the signal was repeated, with precisely the same results, even when the light was

*Distinction.
Red light,
two lights.*

*Special
Inspections.*

viewed from the top of the paddle-boxes, a position nearly equivalent to the horizon. As the yacht approached Waitby, in returning, it was observed that in the southern light it was only the lowest of the lower series of reflectors that were giving any available rays, and that the whole light was cut across the middle by a dark band, suggesting the idea of the central lenticular zone, throwing no light whatever upon that part of the sea.

Additional Observations of Dr. Gladstone on Lights in the English Channel, under Local Authorities.

August 2. — In company with Captain Close visited the

206. RAMSGATE

Vol. II. 354. Red Light, which had been seen the previous evening. As on the previous visit it was remarked that the order and cleanliness almost universal in lights belonging to the general Boards were not exhibited here. On the glass of the apparatus were a great many little spots of paint, which the keeper supposed to have come when the room was painted, a month previously. The keeper at the North Foreland subsequently stated that he cleaned the glass of his light with spirits of wine about twice a week.

The illuminating apparatus is of French manufacture, and some pieces of the glass are full of bubbles. The lamp was lighted, and found to give an external flame of about an inch in height, and an internal one of from two to three inches. The sea horizon, as viewed through the lenses, cut the flame 0·4 inch above the lamp, which is just at the commencement of the bright portion, a good adjustment for throwing the light on to the sea; but it was far otherwise with the reflectors. On looking into the upper series of prisms it was evident that very nearly all the rays emanating from the flame were sent by them up into the sky, and on looking into the lower series all the rays impinging on them appeared to be sent upwards. Thus the upper reflectors are rendered nearly useless, and the lower ones worse than useless, by the want of proper adjustment, and the efficiency of an otherwise good lighthouse is much diminished.

The green light on the cliff was also visited. It is intended to be seen in one with the red light to navigate the channel. It is placed on a cliff and on a tall lamp-post, so that vessels in the harbour can scarcely obscure it: it is a gas lamp with three jets, and a reflector behind that seemed to be tolerably bright; special provision is made for ventilation: the green colour is given by bottle-green glazing; and a common gas lamp near at hand was marked towards the sea. Thus this light shows intelligence in its arrangement, and forms a great contrast to the green gaslight at Dover.

August 17th.—Another green gas lamp was inspected at

192. BRIGHTON.

Vol. II. 24. It stands in a high position at the end of the pier. It has only one jet, and that was found to be leaning very much over on one side. This is enclosed in a large gas lamp, with unusually thick broad framework, and thick green glass. The consequence of this is that the light can be seen only with difficulty on a clear night at the distance of a mile, whereas the common gas lamps on the pier show brightly at much greater distances, and in some azimuths there is scarcely any light at all.

Under this light there is a bell, which is said to be rung during a fog, but only between 4 a.m. and 10 p.m.

August 18th.—The two lights at

193. NEWHAVEN

Vol. II. 349. were visited. They stand on the pier, and are intended for leading into the harbour when brought into

one. The innermost one was found to be a wooden tower, containing a very antiquated arrangement for illumination. It consists of a metallic reservoir for oil with three holes in the upper part, through which rise three cotton wicks. There are no lamp glasses, or other means of regulating the draft, and no means of raising or lowering the wicks except by the point of the scissors. *Defects.* Spermin oil is burnt, which has to be kept hot in winter. The keeper, an intelligent man for his station, mentioned that they had once tried colza oil, but found it unsuited to the lamp, and they had once contemplated burning gas, but the authorities were deterred by the first outlay of laying a pipe from the neighbouring town. So the expensive spermin oil is retained. The lamp smokes so much that the keeper has to clean the place every other day, and he has painted it all black, so as to show the soot and dirt less. Behind the lamp is a segment of a cylinder covered with long narrow strips of quicksilvered glass, not curved, but flat. This reflector being of a primitive character and very old is the worse for wear. Its position in respect to the lamp was improved by the present keeper, but there is nothing beyond his judgment to determine where it is to be placed. Above the lamp is a hole with a cowl and vane over it. In front of the lamp is a window with a broad piece of framework as a support exactly opposite the middle wick, so that the light from this wick is entirely cut off from vessels when in the act of making the harbour.

The outer light is in a small wooden house on the pier, which goes on a railway, and is brought into position at night and shunted out of the way by day. The description of the internal arrangements of the inner light apply equally in this case, only there are in addition red panes of glass in frames which are placed against the window at certain states of the tide.

The keeper, or his mate, remains at night in a little pilot house on the pier. They keep the two lights as clean as can be expected with such lamps.

The tide signals, consisting of flag and balls, and the tide gauge were also observed.

August 20th.—Another visit was paid to the light at

212. SHOREHAM,

Vol. II. 3

principally with the view of observing the adjustment of the dioptric apparatus. The establishment was found as described a year previously but it was in a very dirty condition. This was due to the windy weather, which caused the lamp to smoke to such an extent that even at the time of the visit, which was about noon, flakes of soot were falling from the roof, even on to the dioptric apparatus itself, and they were trodden into the floor and steps of the lighthouse. *Defects.* The keeper complained, reasonably enough, that there were no lockers or other means of keeping his cloths, wicks, scissors, &c. apart.

The dioptric apparatus was made by M. Le Paute, and the workmanship is not equal to that of the more modern ones lately seen. Through the central lenticular band the line of the sea horizon was found to be projected 0·65 inch above the lamp, the image of the open sea extended thence to a height of 0·9 inch, and the inner lagoon and entrance to the harbour stretched from 1·1 inch to 2 inches above the metal. This position seemed to make the most advantageous use of the flame. The upper reflectors were for the most part well placed. There were three rings of lower reflectors. The highest was admirably set to throw the light of the lamp on to the distant sea, as was shown by that portion of the landscape being projected just above the metal of the lamp; the middle and lowest brought the image of the sea against the metal rim itself, so that only the side portions of the light were serviceable through them.

This dioptric apparatus therefore was better adjusted than the superior one at Ramsgate, or than some of the 1st order which have been seen; and this goes far to account for the high character which the Shoreham light bears along the neighbouring coast.

servations by August 29th.—An inspection was made of the light
at Gladstone. at
Vol. II. 424.

213. FOLKESTONE.

It was evening, and the door of the tower at the end of the pier was open, but no person seemed to be in charge of the light, so that it was at the mercy of the public.

The tower is a neat pentagonal wooden edifice, with five windows at top. Opposite each window is a gas burner, and what purports to be a reflector. Four of these burners are bat's wing jets, but so corroded that they were found burning with flames of various shapes and sizes, and behind each is a slightly concave mirror, apparently of brass, but encrusted with oxide and dirt. The fifth is an Argand burner, but the gas could only issue from two of the jets, from which were rising two large separate jets of flame, and behind this was a small ordinary parabolic reflector, doubtless silvered, but retaining no trace of polish. The windows opposite this and the two other burners which showed seaward were of red glass, that which showed towards the harbour and town was colourless, and the remaining one, which was intended for the sea just outside the opposite pier, was dulled by being coated with a thin semi-transparent layer of paint.

Over the burners was a bent ventilating apparatus, but it was rusted through in large holes so as to defeat its object. The inside of the tower was very dirty, and the whole arrangements showed want of intelligence in the first instance, and neglect afterwards.

On August 31st the establishment of Messrs. Sauter at Avenue Montaigne, Paris, was visited. There was little that attracted notice as novel after the visits paid to the similar works of M. Le Paute and Mr. Chance. Some beautiful small pieces of dioptric apparatus, similar to those used in lighthouses, but smaller, were seen. They were intended for ships' lights, and naturally suggested the idea of how necessary it is to keep advancing in the brilliancy of lights intended as permanent signals. In one room there were being fitted up a revolving light for the African coast, and a first order apparatus for the Island of Capri, where it is said there has been no lighthouse since the days of Tiberius Cæsar.

J. II. GLADSTONE.

CAP D'AILLY.

Started for France on the 3rd of September 1860, to join the Astronomer Royal. Our principal object was to examine carefully the adjustment of the lenses at CAP D'AILLY, lighthouse, to ascertain how far they were adjusted to the visible horizon. Landed at Calais, and from thence by diligence and rail to Dieppe.

As this was the second visit I had paid to this first-class lighthouse (see Personal Observations p. 40) it is unnecessary to say more than that we made the most careful observations of each separate lens, and of each of the various prisms, the operation occupying several hours. The result is given in the Astronomer Royal's letter on the subject (see p. 85); and with the opinions there expressed I entirely concur. The prisms, although on the whole well adjusted to the horizon, had apparently not been tested after the frames were erected at the lighthouse, as was subsequently done at South Whitby, in October, 1860, after the defects in that light had been ascertained; otherwise that perfect precision of adjustment, which, as we saw at Whitby, was quite attainable, and which was finally accomplished by Mr. Chance, would have been found at Ailly.

This was not the case; adjoining prisms varied from one another, to an amount sufficient to show that there had been no process of internal adjustment subsequent to erection.

We were detained at Dieppe for two days, and returned to England on the 7th of September.

ALFRED P. RYDER.

11th October, 1860.—Captain Ryder, Mr. Graves, and Mr. Gladstone met a deputation of the Trinity House at

215, 216. WHITBY

for the purpose of witnessing the result of certain experiments carried out by Mr. Chance and Professor Faraday at the South Light. Admiral Hamilton and the Secretary joined the Commissioners in the evening.

12th October.—The Commissioners proceeded to the lighthouses, and several positions were selected distant about 500 yards from the lighthouse from which to view the effect of the changes which had been made.

In the evening the Commissioners viewed the light from three different positions, panels being brought in succession opposite to the points of observation. One position was selected as coinciding with the direction of the horizon, another above it, and a third considerably below it.

A very marked difference was observed in the panels. At the highest position one gave decidedly less light than the others; at the lowest position the same panel gave a great deal more; at the level of the horizon it was very difficult to discover any difference.

It seemed then to be proved that the light thrown above the horizon may be advantageously brought lower, so as to illuminate the sea near the lighthouse without injuring the efficiency of the light as seen from the most distant point of the horizon.

13th October.—The Commissioners again visited the light, and witnessed the method pursued by Mr. Chance in adjusting some of the prisms.

A pole with a white cross board was fixed at some distance and graduated, so that a line drawn from the centre of each prism to the horizon should cut the lower edge of the board. An observer behind the burner within the apparatus looked over a scale placed on the burner through the prism to be adjusted towards the white board, and a workman moved the portion of the prism with wedges until the white board was seen in the required direction.

The prism which had been cast loose in the brass frame was then fixed with plaster of Paris, and each prism in turn was so adjusted. Other panels had been by the same process adjusted, some to throw the centre of the beam of light to the geometrical horizon (that is considerably above the visible horizon), others to points within the visible horizon.

In the evening the Commission embarked on board a steamer provided by the Trinity House, and proceeded to observe the result of the arrangements from the sea.

The North Light had been left as it was found by the Commission on a former occasion for comparison. It was then pronounced to be somewhat superior to the South Light. It was now manifestly inferior when viewed from a distance of a few miles. From the greatest distance reached the difference was hardly perceptible. The difference between the panels which were brought successively opposite to the position of the steamer was in like manner hardly perceptible at the great distance, but well marked from the nearer position.

The central band of lenses was covered, and the same series of experiments repeated with the prisms alone.

The amount of light thrown by these was remarkable. It was thought by some of the gentlemen present that the South Light with the prisms alone was nearly as brilliant in comparison with the North Light as it was previous to the alterations with its full power.

Professor Faraday took full notes of all the proceedings; and it was suggested that the Commission would do well to apply to the Elder Brethren for a copy of any report which he may make, and for their sanction to its publication in the Appendix.

Additional Observations of Admiral Hamilton on Local Lights, East Coast of Scotland.

217. BODDAM,

(Two miles south of Peterhead, Aberdeenshire.)

Lights of this harbour examined on 6th October 1860. They consist of four lights, red, exhibited

Special
Inspections.
WHITBY.

Experiments.

Result.

Adjustment.

Method of
internal obser-
vation.

Experiment.

See page 63.

See Professor
Faraday's
Report, p. 90.

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Observations by
Admiral
Hamilton.

*Special
Inspections.*
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during the fishing season. A large fleet of herring boats frequent this harbour, to whose crews, as well as to those of the Peterhead boats, these lights are of great service. The lamps are furnished with parabolic reflectors eleven inches in diameter. Lamps and reflectors in excellent order,—a condition due to the care and attention of James Chivas, who has charge of the lights. This man is one of the “occasional keepers” in the employ of the Northern Lights Commissioners; and has been six years so employed. He is occasionally stationed at the adjoining lighthouse of Buchan Ness, a light under the Northern Commissioners, and being on good terms with the lightkeepers there, he has borrowed some of their chimney glasses, which are on the French model with sloping shoulders, and applied them to the Boddam Harbour lamps; and the combined results of this man’s acquaintance with his business, and his means of procuring what he knows to be necessary, are a set of coloured lights which are reputed to be not only of the utmost service to the Boddam and Peterhead boats, but to the passing trade generally.

These red lights are produced by coloured shades on glass sides in an extra sized street lamp on a sliding iron pedestal about twelve feet in height. James Chivas had adjusted the stem of the reflectors to the focus of the flame by an ingenious and simple contrivance by means of cut corks, and the result is a brilliant light thrown on the narrow and rocky channels leading to the harbour. The lamps and reflectors seemed to have been originally fitted with small consideration as to their relative connection, whilst their present adjustment seems to illustrate the necessity of a proper inspection of local lights, and the advantage of there being properly instructed persons to take charge of them.

6th October, 1860, 10 p.m.—Revisited

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PETERHEAD.

and examined harbour lights on the night of the 6th October 1860. The lightkeeper, Alex. Machie, had made good use of his time since his appointment and my former visit on the 28th September last year; the valuable apparatus and reflectors were in much better order, several arrangements were more complete, and the lightkeeper evidently desires to do his duty properly.

October 31st, 1860.—The Secretary, by direction of the Commission, travelled to Waterford, arriving on the morning of the 1st.

November 1st.—Observed the buoys in Waterford Harbour. Two conical buoys, intended to float upright, were laid on their sides, the others were clearly visible and showed well, the morning being foggy. Mr. Graves, and Captain Roberts, of the Ballast Board, met the Secretary at Waterford, and it was decided not to visit Mine Head, as the weather was unfavourable.

November 2d.—Drove to Dungarvon, and thence to

IRELAND.

219. MINE HEAD, No. 240,

to inspect the lighthouse, and to ascertain whether any means had been adopted by the Ballast Board for counteracting the evil effects of placing a dioptric apparatus, constructed to throw a level beam on an elevated site.

Mr. Halpin, the Superintendent of Lighthouses, met the Commission at Mine Head.

According to the return of the Ballast Board (page 294), this light was erected in 1851, and the apparatus then placed in it is now in use. It is dioptric, first order, “Made by Wilkins of London,” and its elevation is 285 feet.

The light was previously visited by members of the Commission on the 20th September 1859 (see page 38). In addition to the observations then made, it was remarked that the framework on which the illuminating apparatus stands is of wood, a number of strong beams placed round the edge of the platform, instead of the single metal pillar or metal frame

which generally supports such apparatus. It was stated by Mr. Halpin that this was intended to be temporary, but no change has been made since the light was placed nine years ago.

The framework appeared to be firm and strong, and the apparatus level. It was also remarked that there were no reflectors in the blank space corresponding to the land. With reference to the placing of the burner in the apparatus, it was remarked that observations taken from within could be verified by observations from the shore at points to the eastward and westward at greater or less distances, and a spot was selected from which to view the light subsequently.

A drawing was then made, full size, showing the plan of the burner (obtained by pressing a sheet of paper on it). The size of the flame, and the position of the horizon of the image formed by the refracting portion of the apparatus, and the directions in which the horizon was seen in the catadioptric prisms, both above and below. It appeared that the flame was small, produced by three wicks, in a fountain lamp similar to the lamp, burner, and flame at the Start; and that the burner was well placed for the refracting panels. It seemed that the burner had been raised so as to counteract the effect of the elevated position of the light; but that the upper and lower prisms had not been adjusted to correspond, and, consequently, that nearly all their light was thrown above the horizon. Their position was worse than that of the prisms at Whitby, when they were first seen by the Astronomer Royal and by the Commissioners. The horizon was seen in the upper prisms in a direction corresponding nearly with the edge of the burner nearest to the prism, while in the lower prisms it was seen in a direction corresponding with the inner edge of the inner wick, so that the light was masked.

As the sun neared the horizon the images formed by the different parts of the apparatus in their respective foci confirmed these observations. The image formed by the refracting panels was on the metal of the burner, and rose as the sun descended. At the same moment the images formed by the lower prisms corresponded with the near edge of the burner, and fell below the edge, and descended as the sun approached the horizon.

The images formed by the upper prisms met at a point near the top of the flame, and the rays there crossed each other, and illuminated a sheet of paper on the surface of the burner; but as the sun got lower, the light approached the edge of the burner, the point where the image of the horizon is formed.

The sun was obscured by clouds shortly before it set, so the actual position of the horizon could not be determined by this test; but the observation so far entirely confirmed those previously made in the manner already described. (See *Whitby, North and South Foreland, Start, Point of Ayre, &c.*)

The Commission, accompanied by the officers of the Ballast Board, walked to a rising ground in a field, distant about three hundred yards from the lighthouse, and it appeared by eye observations, and by looking through a telescope, that no light was showing in the prisms, either above or below. It appeared to the Superintendent to be otherwise. It appeared to his vision that, in spite of the observations made inside, light was seen in all the lower prisms, and in most of the upper ones also. A lighthouse keeper was accordingly despatched with orders to cover up the “central panel.” It appeared to the Commission that one man had misunderstood the order, and that he had covered the large central zone only without covering the refracting prisms, for two spots of light could be seen with a dark space between; and the man and the cloth could be distinguished with the telescope, showing against the sky.

It appeared to be otherwise to the Superintendent, who still thought that the light seen proceeded from the upper and lower prisms.

Captain Roberts was accordingly requested to proceed to the lighthouse and see the experiment carried out. He did so; and it became evident to all present

Drawing.

Direction of beam.

Experiment. Sunlight.

See drawings at the end of this Vol.

Internal observations.

External observations.

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Apparatus.

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7, Millbank Street, S.W.

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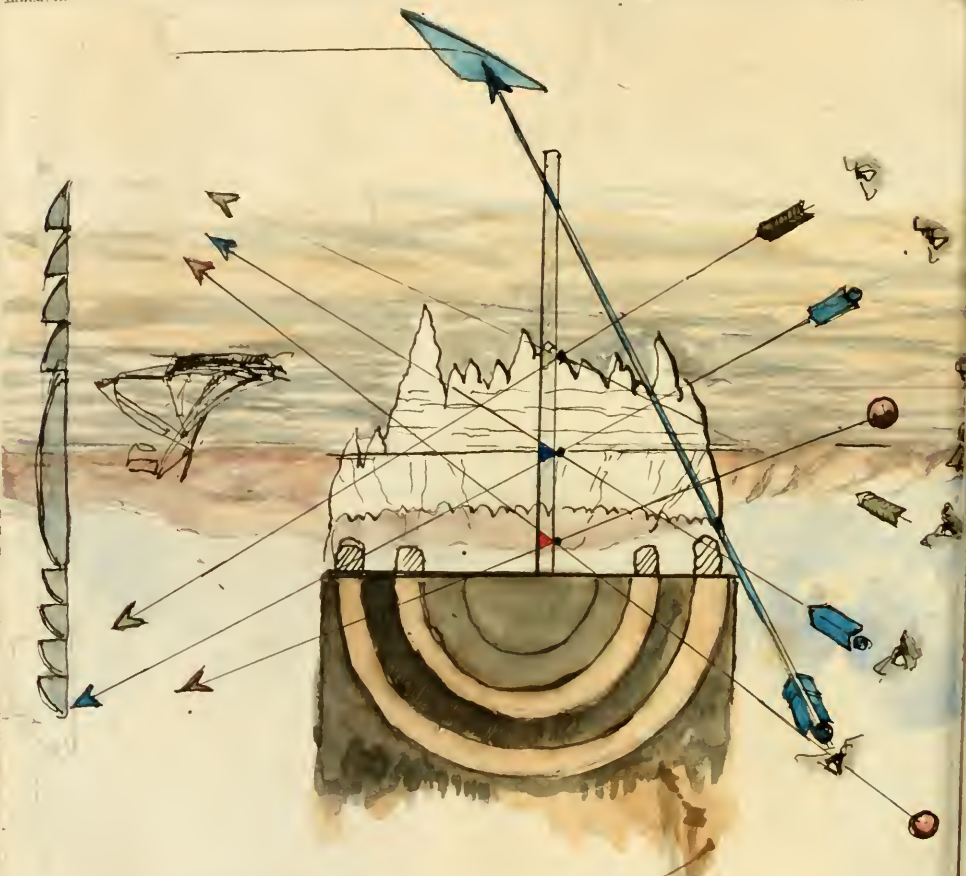
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Yellow. Rays which go to the place where vessels pass.

Blue. " " " " " Horizon.

Red. " " " " " Hill distant 3 miles
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Apparatus.

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*Special
Inspections.*
Vol. II. p. 394.

during the fishing season. A large fleet of herring boats frequent this harbour, to whose crews, as well as to those of the Peterhead boats, these lights are of great service. The lamps are furnished with parabolic reflectors eleven inches in diameter. Lamps and reflectors in excellent order,—a condition due to the care and attention of James Chivas, who has charge of the lights. This man is one of the "*occasional keepers*" in the employ of the Northern Lights Commissioners; and has been six years so employed. He is occasionally stationed at the adjoining light-house of

which generally supports such apparatus. It was stated by Mr. Halpin that this was intended to be temporary, but no change has been made since the light was placed nine years ago.

The framework appeared to be firm and strong, and the apparatus level. It was also remarked that there were no reflectors in the blank space corresponding to the land. With reference to the placing of the burner in the apparatus, it was remarked that observations taken from within could be verified by observations from the shore at points to the east-



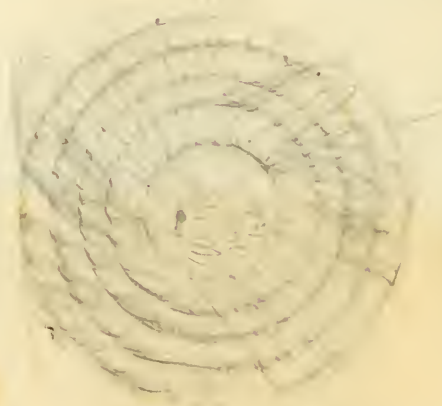
Royal Commission,

Lights, Buoys, and Beacons,

7, Millbank Street, S.W.

London.

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IRELAND.

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Apparatus.

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Royal Commission,

Lights, Buoys, and Beacons,
7, Millbank Street, S.W.
London.

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object of the interview
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the returns without

Special
Inspections.
—
Ballast Board.

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Liverpool.

LIVERPOOL,
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consideration of the use to which it is to be put, and with-
out giving directions, or information to guide the
manufacturer in its construction. The apparatus at
Mine Head wants adjustment, not because it is ill-
made, but because it is placed 285 feet above the sea.
The apparatus at Dungarvon wants nothing, unless it
be a better flame, *not* because it is better made, but
because it is placed 230 feet *lower*.

The horizon was seen in the upper prisms in the
direction of the *farthest* edge of the burner, instead of
the *nearest*, and, consequently, nearly all the light of
the lamp is thrown by the prisms on the sea, and to a
point where vessels pass into the harbour near the
lighthouse.

The horizon of the image formed by the lenticular
zones is high, as was anticipated; but if the flame is
maintained at the proper height, it is not too high.
If the flame be allowed to burn low, the lenses might
become of little use; but the prisms would always
show light so long as the lamp is burning; and this
apparatus being placed at the elevation for which it
was made, is efficient, as it came from the maker and
without adjustment.

The bars of the lanterns of both these lights are
upright, instead of diagonal, and there are no re-
flectors on the landward side. The lamps in both are
fountain lamps; one wick is suppressed in each, and
the flames of both lamps were far inferior to flames
seen elsewhere.

The Commission returned to Waterford, and
travelled to Dublin.

November 5th.—The Secretary visited the office of

the apparatus, and at the same time to determine at
what height above the burner the focus should be
placed. The means of performing the experiments
had been seen and approved by Professor Faraday.

The arrangement was as follows:—Near one end
of a long dark shed was placed a four-wick moderator
lamp, with a good slanting shouldered glass chimney,
and a metallic chimney with damper as in an ordinary
lantern. This lamp could be raised or lowered at will
with great precision. At the proper distance in front
of the lamp was erected a series of lenticular bands,
such as are employed in a first order dioptric appa-
ratus. Before these again were sliding shutters, so
that the light which had traversed any one of these
lenticular bands might be stopped or allowed to pass
beyond. On the wall at the further end of the dark
shed, at a distance of about 36 yards, was a very
large sheet of paper, which received the light through
the dioptric arrangement. In front of this sheet was
a thin horizontal arm moving along an upright, which
was graduated, with marks answering to the heights
of the centres of the different lenticular bands.

When the lamp was raised to zero on the scale
annexed to it, the top of the burner was precisely on
a level with the centre of the central lenticular band
and with the corresponding mark on the upright
against the sheet of paper. When it was lowered,
say 28 m., it is evident that rays proceeding from
points 28 m. above the burner, and passing through
the centre of the central band, should strike the
paper against the corresponding mark; and that this
was actually the case, was proved by placing a small
gas-jet at the same mark, and viewing it through the

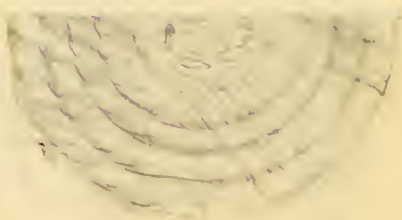
Arrangements.
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Apparatus.

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that no light, except a faint reflected light, could be seen in any of the upper or lower prisms.

In this case then there can be no doubt that the upper and lower prisms are for all practical purposes almost useless for want of adjustment, for three methods of observations lead to the same conclusion.

The prisms could either be adjusted by moving them in their frames, or by raising the whole upper frame till the image of the horizon appears at the proper place; if this latter course be followed, it will be necessary to make some provision for raising the lower prisms, either by cutting off part of the lower refracting panel, as was suggested by Mr. Chance elsewhere, or by some other method; or the upper prisms might be raised all together, and the lower prisms moved in their frames. It would be better to lower the burner, with reference to the refracting panels, about an eighth of an inch, for the burner now intercepts a considerable portion of the light which should fall on the lower portion of the refractors; but if this be done it will be necessary to increase the size of the flame materially, for there is nothing to spare at present.

At all events this light should be adjusted as soon as possible; and if the lighthouse authorities desire to carry out experiments such as those tried by the Trinity House at Whitby, the position is in every respect peculiarly favourable for the purpose.

A portion of the upper prisms is masked by the eclipsing shade when open.

220. DUNGARVON.—No. 139.

It was remarked that the light at the entrance to Dungarvon was seen from the hill at a point considerably higher than Mine Head, probably more than 300 feet above the sea. It seemed probable that the image formed by the apparatus was high, and it was decided to visit the light.

November 3d.—The same party visited the light. It is called third order, and 52 feet above the level of the sea, the apparatus being of the same pattern as that at Mine Head, but without lower prisms, and smaller. Two wicks only are used, with a fountain lamp. A drawing was made similar to that made at Mine Head, and these two show plainly the effect produced by placing an apparatus constructed for one situation in another; that is to say, the result of placing a highly scientific instrument, such as a dioptric apparatus is, without mature consideration of the use to which it is to be put, and without giving directions, or information to guide the manufacturer in its construction. The apparatus at Mine Head wants adjustment, not because it is ill-made, but because it is placed 285 feet above the sea. The apparatus at Dungarvon wants nothing, unless it be a better flame, *not* because it is better made, but because it is placed 230 feet lower.

The horizon was seen in the upper prisms in the direction of the *farthest* edge of the burner, instead of the *nearest*, and, consequently, nearly all the light of the lamp is thrown by the prisms on the sea, and to a point where vessels pass into the harbour near the lighthouse.

The horizon of the image formed by the lenticular zones is high, as was anticipated; but if the flame is maintained at the proper height, it is not too high. If the flame be allowed to burn low, the lenses might become of little use; but the prisms would always show light so long as the lamp is burning; and this apparatus being placed at the elevation for which it was made, is efficient, as it came from the maker and without adjustment.

The bars of the lanterns of both these lights are upright, instead of diagonal, and there are no reflectors on the landward side. The lamps in both are fountain lamps; one wick is suppressed in each, and the flames of both lamps were far inferior to flames seen elsewhere.

The Commission returned to Waterford, and travelled to Dublin.

November 5th.—The Secretary visited the office of

the Ballast Board, and had an interview with Mr. Lees their secretary. The object of the interview was to impress on Mr. Lees the urgent necessity of furnishing the remainder of the returns without delay.

November 6th.—The Secretary visited

221. BIDSTONE, near LIVERPOOL,

to see whether any provision is there made for adjusting the apparatus to correspond with the elevation. A drawing was made which shows the position of the image formed by the back of the reflector, from which it appears that the image of the horizon is very high, and that if the flame burns low, the light might become invisible at the horizon. The edges of the reflectors were found to be set perpendicularly. It might be well to incline them a little downwards; but as the seashore is distant some three or four miles, the adjustment is not so important as it would be if the lighthouse were placed at the same elevation, and near the sea. The shape of the chimneys is objectionable. The reflectors are 35 years old; and though some of them might be brighter, they were generally in much better order than when last seen by the Commission.

The window through which the light shows is composed of small panes and thick bars, which must materially interfere with the light. On the whole, Bidstone compares unfavourably with other lights under the General Lighthouse Authorities; not in that it is badly kept, but in that none of the modern improvements introduced into lighthouses elsewhere have been adopted.

It is out of date, but well preserved. The house was neatly kept; but in some disorder, in consequence of the presence of the painters.

VISIT TO BIRMINGHAM.

On 3d and 4th December, Capt. Ryder, Dr. Gladstone, and the Secretary, accompanied by the Astronomer Royal, witnessed some experiments at Messrs. Chance's, near Birmingham. On the 4th they were joined by Mr. Thomas Stevenson.

The experiments had been instituted by Mr. James Chance, with a view to apply to the lenses the same principle of rigorous adjustment, which had already been applied with success to the reflecting portions of the apparatus, and at the same time to determine at what height above the burner the focus should be placed. The means of performing the experiments had been seen and approved by Professor Faraday.

The arrangement was as follows:—Near one end of a long dark shed was placed a four-wick moderator lamp, with a good slanting shouldered glass chimney, and a metallic chimney with damper as in an ordinary lantern. This lamp could be raised or lowered at will with great precision. At the proper distance in front of the lamp was erected a series of lenticular bands, such as are employed in a first order dioptric apparatus. Before these again were sliding shutters, so that the light which had traversed any one of these lenticular bands might be stopped or allowed to pass beyond. On the wall at the further end of the dark shed, at a distance of about 36 yards, was a very large sheet of paper, which received the light through the dioptric arrangement. In front of this sheet was a thin horizontal arm moving along an upright, which was graduated, with marks answering to the heights of the centres of the different lenticular bands.

When the lamp was raised to zero on the scale annexed to it, the top of the burner was precisely on a level with the centre of the central lenticular band and with the corresponding mark on the upright against the sheet of paper. When it was lowered, say 28 m., it is evident that rays proceeding from points 28 m., above the burner, and passing through the centre of the central band, should strike the paper against the corresponding mark; and that this was actually the case, was proved by placing a small gas-jet at the same mark, and viewing it through the

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Ballast Board.

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Dr. Gladstone's
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apparatus.

Experiments.
Flame.

Arrangements.
Apparatus.

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*Special
Inspections.*
*Professor
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Experiment.

central lens above the edge of the apparatus devised by Professor Faraday for such purposes when the Whitley Lights were under discussion. It is evident also, that if, when the lamp is in the aforesaid position, the brightest section of the flame is at the height of 28 m. above the burner, the brightest portion of the light thrown on the paper will coincide with the mark that corresponded with the centre of the central band; supposing, of course, that any disturbing rays from the upper or lower bands are cut off by the sliding shutters. If, however, the brightest section of the flame is higher than 28 m., the brightest portion of the luminous image on the paper will be below the said mark; and conversely, if lower in the flame, higher in the image. But the lamp being susceptible of elevation or depression, it was easy to move it till the brightest part of the light fell on the paper at the central mark. Nor was there any great difficulty in determining this: simple observation at a distance, the effect on a secondary shadow thrown across the paper, and Mr. Stevenson's photometer, all led to the same conclusion, and different observers agreed in their judgments. By this means the following points were determined.

*Mr. Stevenson's
photometer.*

Results.

1st. That as the flame increases, the section of greatest luminosity rises. With a low flame, but such as was seen at the Start or Mine Head, the brightest portion was only 18 m. above the burner; with a better flame it was 20 m.; and with the best that was obtained during the experiments it rose to 24 m. This flame presented considerable body, and might be taken as a very good specimen of what is found in an English 1st order dioptric apparatus, but was believed to be inferior to what is maintained in many Scotch lights, and was certainly smaller than what had been seen by the Commissioners at Calais and other places in France. It is possible, therefore, that in these best flames the brightest portion is really 28 m. above the burner, the height decided on by Fresnel for the focus of the lens; but it is beyond question that where in English lighthouses the focus has that position, the brightest portion of the light is ordinarily sent to the sky. Where the dip of the horizon is not taken into consideration, this error of adjustment is aggravated, as in the South Whitley Light, where the focus being 35 m. above the burner, must have been above the most luminous part of the best known flame, supposing such had been burnt in it.

2nd. That the section of greatest luminosity in a flame of this description is practically confined within narrow limits. There was no difficulty in determining it to one millimetre.

Besides the amount of oil consumed, the height to which the several wicks are turned up, the form of the lamp-glass, and the character of the draught, must all have their influence on the height of this section of greatest intensity.

Observations were made on the different upper and lower lenticular bands, by means similar to those already described. It was not so easy to determine the position of the greatest brightness in the images thrown on the paper by rays that traversed these lenticular segments, as they exhibited the prismatic colours, but the whitest part, which was about equally removed from the red and the blue, was assumed as such. This chromatic aberration was greater as the lenticular segment examined was further from the central band, and it was more apparent in the lower than in the upper series. The following conclusions were arrived at:—

1st. Supposing that the foci of the upper and lower lenticular bands coincide with the focus of the central band, it does not follow that the brightest section of the flame as regards each of them, also coincides with the brightest section as regards the central band. In fact, the brightest section of the flame, as regards the lowest bands, was found to cut the vertical axis of the flame at a higher point than had been previously determined for the central band.

2nd. On account of this, and because when the section of maximum intensity for the central band is near the burner (say at 20 m.), a portion of the light that should fall on the lowest bands is cut off by the burner itself. Mr. Chance proposes that the foci of the lower bands should not be taken at the same point as the focus of the central band, but that they should be treated much in the same way as the lower reflectors are treated, viz., that some point a little above the burner and in front of the vertical axis of the flame, should be taken as the point of intersection of the axis of pencils of rays proceeding to these lower lenticular bands; but it is evident that this is of less importance in a high flame than in a low flame.

*Proposed
remedy.*

3rd. As the chromatic dispersion of the upper and lower bands is in the reverse order, that is to say, the red rays are sent upwards by the upper bands and downwards by the lower, and the converse holds good for the blue rays, the two series of bands may be so adjusted that the chromatic images produced by them should overlap and neutralize one another, producing throughout white light, or an approach thereto. This could be only very partially shown in the actual experiment, as the distance at which the paper was placed was too short to admit of much overlapping.

4th. Though the colour due to this chromatic aberration may be thus disposed of, the dispersion itself must always remain, when lenses of the kind now in use are employed, and this may be a matter worthy of attention when further refinements are required.

These experiments confirmed the opinion entertained by the Commissioners as to the great importance of keeping up a large consumption of oil, and therefore a large flame, by showing that when the flame sinks, not merely is less light actually produced, but the most luminous section of the flame sinks below the focus, and is accordingly sent to the sky. Indeed, before a dioptric apparatus can be properly adjusted, it must be known what size of flame is meant to be continuously exhibited.

Conclusion,

The man who attended the lamp showed the Commissioners the large amount of charring that took place in the inner wick after only one hour's combustion. Mr. Stevenson stated that the Scotch keepers will burn a lamp for 16 hours without in any way trimming the wicks.

*Charring of
wick.*

An arrangement similar to that described above was made with a pump lamp and a circular compound lens. An inverted image of the flame was thrown on the paper, which became much more definite when the light proceeding from the central portion was stopped. No measurements were taken, but the result appeared to be much the same, as in the preceding experiment.

Photographs and measurements of the flames experimented on were taken by the Secretary.

*Photographs,
&c.*

The Commissioners were also shown in the works an apparatus just completed for McArthur's Head. It is of a small order, but is interesting from its including two of the azimuthal condensing arrangements, by which Mr. Stevenson brings the light of one half of the circle into two directions which he desires especially to illuminate.

*Azimuthal
condensing
apparatus.*

Under the same roof was also the frame for the 1st order apparatus to be erected at the Smalls. It had been designed by the Trinity House, but the Messrs. Chance, after it was made, had to point out its defects to the Board, and to obtain their sanction to make large alterations at great cost; but even now the Astronomer Royal doubts whether the angle pieces of the slanting astragals are strong enough to withstand the great weight they will have to bear. The design adopted in the adjoining apparatus for McArthur's Head was thought to be much stronger and less obstructive of the light.

*Apparatus
Smalls.*

The designs for the supplemental lantern and the dioptric apparatus intended for the electric light at Dungeness were seen by the Commissioners.

Electric light.

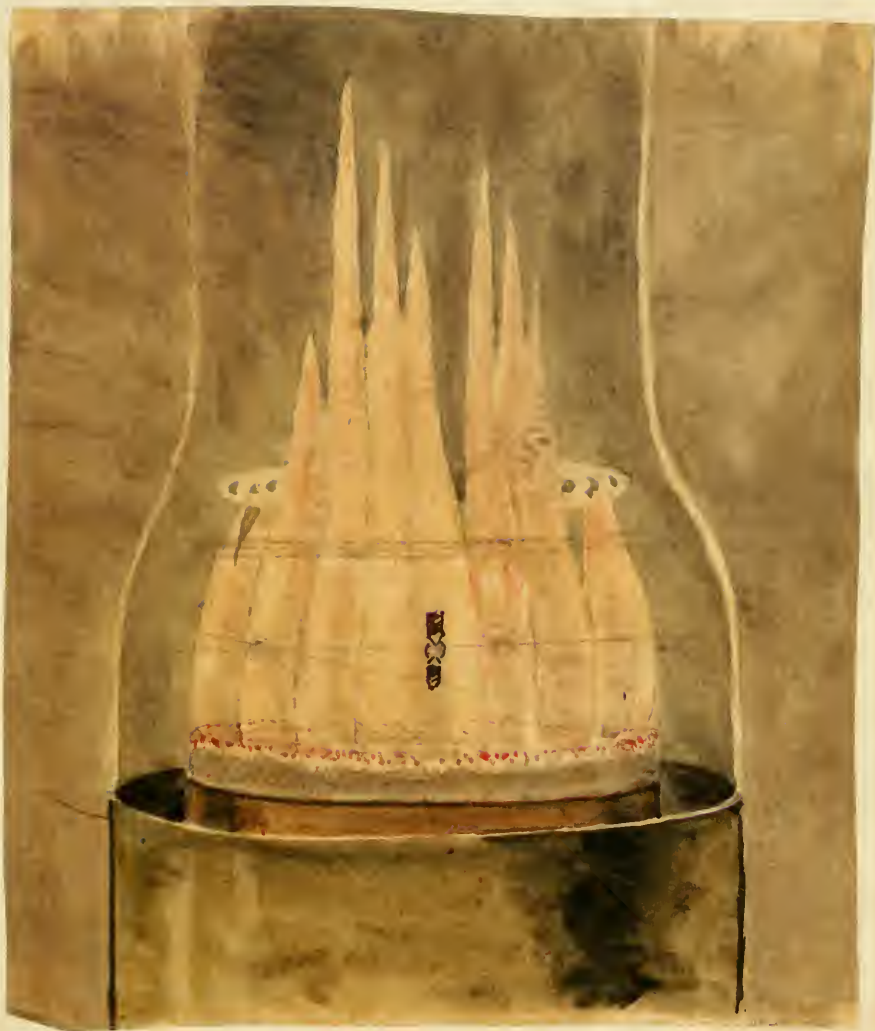
*Chromatic
aberration.*

Royal Commission,

Lights, Buoys, and Beacons,

7, Millbank Street, S.W.

December 4 1860 London.



Drawn on ground glass, in a Photographic
Camera. - J.H.

It was the same on the morning of the
4th. but it was higher & better than the same
on the night of the 3rd of which. Photographs
were taken.

The same lens was taken on the 5th of December
from the same point.

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SUMMARY OF PERSONAL OBSERVATIONS OF THE COMMISSIONERS ON THEIR VISITS TO WHITBY LIGHTHOUSES.

The members of the Royal Commission having concluded their visits of inspection to French, Spanish, and British Lighthouses, and examined carefully the system adopted in each country, and having formed an opinion of what a first class dioptric light should be, determined to select one or more of the first order dioptric Lighthouses of each of the three General Lighthouse Authorities in the United Kingdom, and then to compare them with one another and with the ideal lighthouse.

The Lighthouses selected were those at—

North Foreland } England,
Whitby }
Girdleness—Scotland.
Minchhead—Ireland.

The following errors and deficiencies were observed at Whitby:—

- I. *Glass Chimney* [abrupt shoulders obstruct light].
- II. *Metal Uptake* [not continuous, draught diminished].
- III. *Fountain Lamp* [very inefficient, because can never produce a high flame].
- IV. *Central Wick* [removal of, has diminished light].
- V. *Burner and Lamp* [no means of adjusting; great difficulty of maintaining foci in right place].
- VI. *Lens* [error in position of one of them; portion of light mis-directed and wasted].
- VII. *Lower Prisms* [useless, all light wasted].
- VIII. *Upper Prisms* [some out of adjustment; large portion of light mis-directed and wasted].
- IX. *Platform* [out of level; light more or less mis-directed].
- X. *Adjustment of Lamp Lenses and Prisms* [no attention paid to dip, waste of best light].
- XI. *Glass* [in some prisms streaky, light scattered, and more or less wasted].
- XII. *Reflectors* in land angle [none in north lighthouse; light in land angle wasted; reflectors in south lighthouse badly figured].
- XIII. *Filter* [none; oil soiled; flow probably impeded, and brightness of flame diminished].
- XIV. *Distinctive Character of Lights* [Two first-class dioptric lighthouses an unnecessarily expensive means of distinction].
- XV. *Relative Height of the two Lights above the sea* [same height above sea; impossible to know which light is open when they are nearly in one, if the weather is thick and the red light not easily distinguishable from the white].
- XVI. *Height of Flame of the Mechanical Lamp in South Lighthouse* [placed there in consequence of the Commissioners' first visit very insufficiently maintained by the keeper, consequent inefficiency of light both to near and distant ships].
- XVII. *Site* [it is questionable whether well selected].

The two first order dioptric lights at Whitby have lately been erected there within 258 yards of one another. The illuminating apparatus were constructed by the Messrs. Chance, of Birmingham, in 1858, and are situated at a height of 240 feet above the sea. The Whitby lights were selected by the Royal Commissioners for inspection and comparison (1), because they were of the latest construction; (2), because the illuminating apparatus was constructed in England; (3), because the construction was undertaken by a firm, which has the privilege of being aided by the mathematical talents of Mr. James

Chance (a High Wrangler of Cambridge) whose presence ensured the recognition of scientific principles in their construction;* (4), because their height above the sea would enable us to ascertain whether any, and if any, what adjustment had been made to allow for the dip. These considerations pointed out the Whitby lights as fit and proper tests, whether the knowledge of the science of sea illumination, as exhibited in England by the Trinity Board in charge of the Lighthouses, aided by the long experience of Professor Faraday (who, however, disclaims any special knowledge of optics) and the acquirements of Mr. James Chance, had made sufficient progress and kept pace with the strides made in other cognate sciences. In short, we hoped to find that, although France might have a much greater number of 1st class dioptric lights than England has as yet fitted (owing to her having been saddled with much fewer old fashioned lights than England had when the lens system was invented), yet that an English first order dioptric of late construction would prove to be not only in no way inferior to the best French lights, but as near perfection as possible, both as to the flame and as to construction and adjustment of illuminating apparatus and lamp.

The Whitby lights were therefore exposed to the severest tests that occurred to us, or were suggested to us, and we invited to the inspection of them the Astronomer Royal (who preceded us); Mr. J. Chance, the constructor, and his foreman, Mr. Masselin; Professor Faraday, the scientific adviser of the Trinity Board; Mr. Stevenson, the Scotch Lighthouse engineer; Mr. Halpin, the engineer of the Ballast Board; M. Sauter, a French constructor of lighthouse illuminating apparatus; and the Elder Brethren of the Trinity Board, who were represented by Admiral Gordon, Capt. Close, Capt. Baily, Capt. Nesbitt, &c.

We have little hesitation in stating that all of the above-named gentlemen on leaving Whitby would have admitted, if questioned on the subject, that the illuminating apparatus in those lighthouses were faulty in most of the preceding particulars; and we regret to say, that we have reason to believe that a French first order dioptric light is, owing to the greater height of the flame and to other minor causes, much more effective than an *English* first order dioptric light.

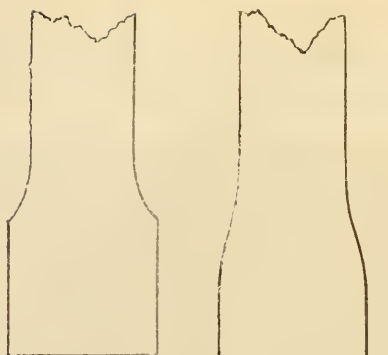
1. The Glass Chimney.

The glass chimney was of the usual shape supplied by the Trinity Board, and was, as stated by Mr. James Chance, *not* like the chimney supplied by his firm to the Whitby light [with the illuminating apparatus], the shoulder being much too abrupt. We ascertained that there was a large stock of Mr. Chance's chimneys [similar to the French chimneys] in the lighthouse;

* It is due to Mr. James Chance to state, that the orders given to him are simply to construct a certain well-known apparatus (Fresnel's dioptric illuminating apparatus) of a given size. Up to the time of the commencement of our inquiries, he had not directed his mathematical researches into investigations connected with the scientific questions bearing on the subject.

Mr. Chance was never informed of the height of a proposed lighthouse; and that very inferior description of lamp, the fountain, was ordered of another firm, leaving him no option in the matter.

It is due to Professor Faraday to state, that he has always disclaimed being considered an optician. It is due also to the Elder Brethren to state, that they make the same disclaimer. They appear to have placed implicit confidence in Fresnel's calculations, and supposed that his adjustments were applicable to any height of flame, and that there was no necessity for testing the adjustment of prisms and lenses after the illuminating apparatus had been erected at the lighthouse, or that the height of the light above the sea need be taken into account in adjusting the position of the lamp.



Trinity Board Chimney.

Chauce's and French Chimney.

but the Lighthouse Keeper thought it to be his duty to expend all that were left of the old pattern before he commenced using the chimneys of the more modern and improved shape.

The shape of the shoulder has, no doubt, an effect on the draft; but whatever may be the difference of opinion as to the advantage in regard to the draft in having a gradual or an abrupt shoulder, we have ascertained quite beyond a doubt that an *abrupt* shoulder will refract the light irregularly, so that many rays will, on passing through, be deflected from the horizontal direction.

Ocular proof of above statement.

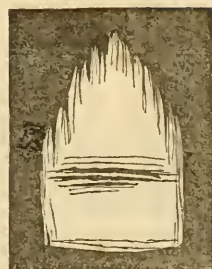
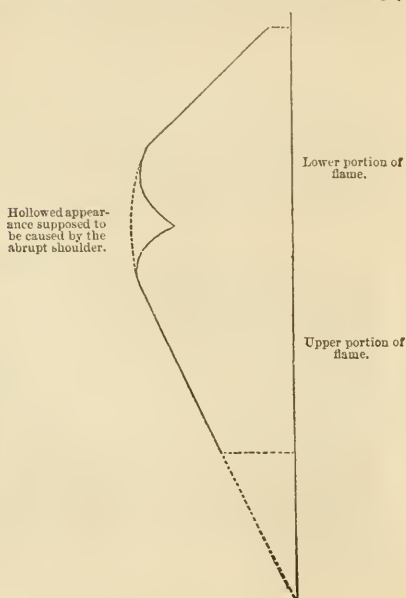
Several horizontal dark lines were observed, apparently in the shoulder of the chimney, and coinciding with that portion of the flame where the image of the horizon was formed, and from which the horizon was illuminated; these dark lines pointed out that rays were intercepted which would otherwise have gone to the horizon.

Photometric proof of above statement.

See Vol. I.
102, diagram.

Mr. Stevenson showed us the result of some very interesting experiments, to ascertain the degree of intensity of the flame when seen through various sections of the lens, and we noticed a remarkable indentation in the curve, probably caused by the abrupt shoulder in the chimney.

Curve of intensity as ascertained from careful observations by three observers ascending Salisbury Crags,



(a.)

Rough sketch of a photographic representation of flame with dark horizontal lines.

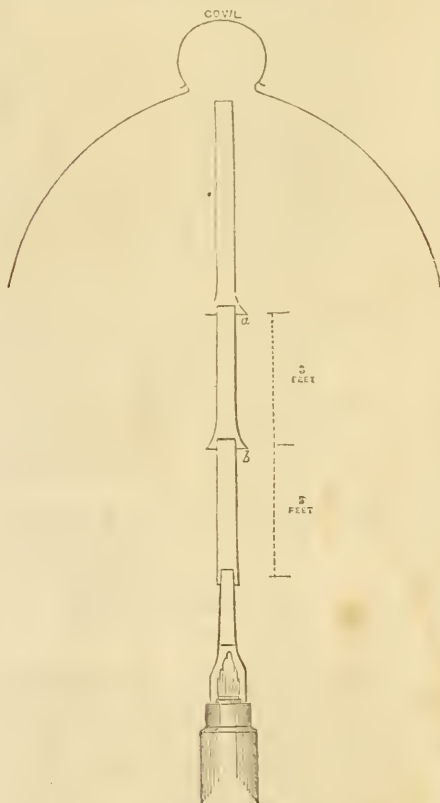
Photographic proofs.

(a.) Mr. Campbell produced a photographic picture, See Vol. II. 625. of which the above is a rough sketch, of a flame seen through a glass chimney, with an *abrupt shoulder*, by which the effect of the abrupt shoulder in producing dark opaque lines was clearly shown Fig. (a).

(b.) M. Sauter produced photographic pictures of flames seen through the *French chimney*, in which the shoulder is very gradual, and no such dark lines appeared.

Mem.—Orders, it was understood, were given on the spot by the Trinity Board to substitute generally the gradual shouldered chimneys for those with abrupt shoulders.

II. Metal Chimney or Uptake.



In the 1st order lights, the distance from the top of the glass chimney to the cowl is considerable, probably 12 feet at least; this space is occupied by a metal chimney in two lengths of about 6 feet each; and the lower length is again subdivided.

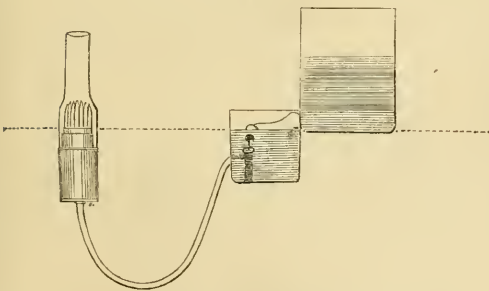
The openings *a b*, were suggested some time since (15 or 16 years) by Professor Faraday, and adopted by the Trinity Board, to prevent a down draught from the cowl in windy weather. Under the impression that the annular opening at *b* admitted too much air, and thereby injured the draught and lowered the flame, we tested the assumption by filling up the annular space with paper, which had a most remarkable effect. The permanent flame was raised in the North Lighthouse, from about 2 in. to nearly 3 in., and in the South Lighthouse from $1\frac{1}{2}$ inch to more than 2 inches. Closing (*a*) did not have much additional good effect.

The opening (*a*) may, therefore, be left to carry out Mr. Faraday's remedy for down draught. This experiment showed that there was not sufficient draught, that a six feet metal chimney or uptake was very much more effective in producing an upward draught than the three feet tube; but it was asserted by Mr. Faraday that the beneficial effect could not be maintained unless the oil was supplied more copiously than at present by the inefficient fountain lamp universally supplied by the Trinity Board to the 1st order, dioptric lights.

III. Fountain Lamp.

The fountain lamp universally used in dioptric lights by the English and Irish Lighthouse Boards consists of a reservoir of oil slightly raised above the burner. The pressure of the oil, owing to this difference of level, forces the oil through and past the wicks. We observed that the oil overflowed very languidly; and were told that if the difference of level was increased by raising the reservoir (the most evident remedy), the vessel that catches and retains the oil that has overflowed, would become full so frequently as to inconvenience the lightkeepers, an argument to which we did not attach much weight or importance. We caused the level to be slightly raised, and the increased overflow had an immediate beneficial effect in raising the flame; but this method of keeping a high flame, owing to the irregularity of the supply of oil, is very inferior to the overflow lamp. The irregularity arises in the following manner. If the influx of oil in a fountain lamp is increased by the attendant, the flame immediately rises, the pipes quickly become hot, the specific gravity of the oil in the rising branch is diminished, the influx of oil is increased with great rapidity, and the flame becomes extravagantly high, smoky, and unmanageable.

The keeper at St. Catherine's (Isle of Wight), states, that when the oil is thick, he raises the reservoir so as to increase pressure.



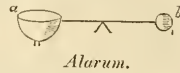
A Fountain lamp.

The level of oil in lower reservoirs is maintained by means of a float, at just the same height as the wick.

The *Overflow Lamps* used in France and Scotland in the 1st order lights; but which for very insufficient reasons (see letter from Trinity House, 3rd January 1861,) have been discontinued in England, force over three times as much oil as they consume; whereas the fountain lamp as at present constructed forces over less than is consumed.

The moderator and the triple or quadruple pump worked by machinery are the two descriptions of overflow lamps in use in France. (The triple pump only is used in Scotland, they are said to be

equally effective); a small alarum is fitted to them in France, which warns the keeper the instant that the overflow diminishes in rapidity.

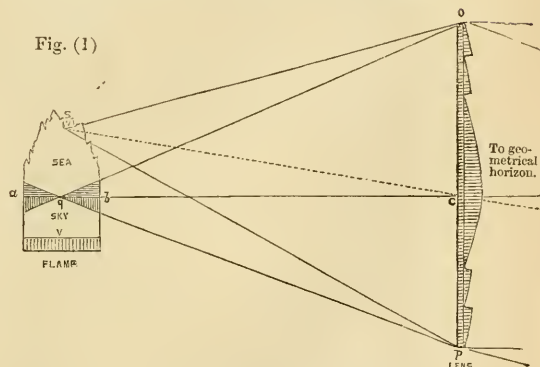


Alarum.

a is a cup with a small hole in it, balanced by the weight *b*; the cup is periodically filled from the overflow; when full, its weight depresses it, and rings a bell.

If the overflow ceases to pass over with sufficient quickness to fill the cup, and thus ceases to overcome the drain through the hole, the cup becomes entirely empty, and sets off the alarum.

It is of great importance that the high rate of overflow be steadily maintained, for the draught being considerable and the flame high, a failure in the oil supply is attended with the following result. The oil, instead of being passed over in proportion of 3 to 1 of the oil consumed, a proportion which, by the coolness of the oil, keeps the metal holder and wick cool,* and prevents the rapid consumption of the wick by charring, is passed over in some lower ratio, the wick becomes charred, smoke is created, effective flame is first diminished, and the light at last either extinguished by the oil or the oil becomes so heated as probably to injure the burners when the flame has burnt the wick down close to the top of burner. Great watchfulness is therefore necessary to maintain the high flame (which we observed to be universally maintainable in France and Scotland in the overflow lamps. See figs. 1 and 2, at end of Vol. I.) With proper and constant care, when the overflow is considerable, the wick need not be trimmed throughout the night. The fountain lamp in use in England in 1st order lights, if we may judge by the Whitby Lights, cannot maintain anything more than a low flame; see personal observations at North Whitby, page 56. (The flame at the South Light was still lower. This difference was probably owing to a variety at the Whitby Lights in the size of the supply tubes or in the draft.) There is an evident loss of a large portion of the light if a low flame is substituted for a high flame. This loss is greater than is due to the mere diminution of light produced, for if the burner and the illuminating apparatus have been adjusted to one another for Fresnel's position of the foci (which had reference to a very high flame, and which position has always been given in England, although the flames are only half the height of Fresnel's) the section of greatest luminosity falls below the focus for parallel rays (*q*) in subjoined diagram, and the strongest light is therefore sent to the sky. Again, those



* The oil in contact with the flame, by its rapid change, is sufficiently cool to prevent the wick from being charred, but the whole of the oil is sufficiently raised in temperature to prevent it becoming thick in winter. This last is an additional recommendation of the overflow lamp compared with the fountain lamp, as at present constructed, in which the oil becomes cold and thick in frosty weather.

portions of the flame above the focal line of the lens (which are the portions lost when the flame is low), are of the *utmost* importance to the illumination of the sea between the horizon and the base of the Lighthouse, and of *considerable* importance to illuminating the horizon also.

Let s, r , fig. (1) be a full flame; a, g, b, r , a low flame; a, b, c , the focal plane of lens; g , the focus; o, p , the lens; then, if the flame does not extend above a, b , (the focal plane) it is evident that only half as much focal light will go to the horizon through the lens as would go there if the flame was sufficiently high to reach above the shaded triangles. Rays from all portions of the vertical section of the high flame *above* the shaded triangles will, after passing through the lens be depressed, and illuminate the sea, showing how important for the near portions of the sea is a high flame.

All rays from portions of the flame *below* the shaded triangle will, after passing through the lens, go to the sky. This shows how important it is that the focal plane of the lens should pass through the flame at its *lowest* section of maximum intensity, so that as few as possible of the brightest rays may be wasted on the sky. The height of the centre of the section of maximum intensity was estimated by Fresnel to be 28 mm., or about 1.1 in. above the burner in a 1st class dioptric. This height was not even approached at Whitby.

The great importance of a high flame is also exemplified when we consider the action of the *upper prisms*.

The curvature of the side a, b , fig. (2) is so calculated* as to send out as parallel rays to horizon all rays arriving from the focus d (or from wherever it may have been determined to place that focus) in the flame. Any diminution in the height of the flame, as for instance from m to n , will evidently diminish considerably the number of luminous points included in those two illuminating triangles, and thus diminish the light proceeding to the horizon.

In the same way any diminution of the height of the flame will diminish the number of rays sent by the *lower* prisms to the horizon, for, as is evident in fig. (3), the upper shaded triangle does not exist as a luminous body when the flame is lowered from m to n . We have in both of the two last figures shown by the words *sky* and *sea*, where the rays from those portions of the flame anterior and posterior to the focal planes are sent to, if the rays are not intercepted.

It has been stated by Fresnel, and hitherto generally accepted by makers of illuminating apparatus, that the focal plane for the *lens* of a 1st class dioptric should be about 1.1 in. above the burner to ensure that the focus be in the brightest part of the flame, but Fresnel in giving this height referred only to the high flame of a mechanical lamp. A complete series of experiments is yet wanting to ascertain which is really the brightest section of flames of different heights as seen from the *lens* and from the *upper* and *lower* prisms. When these have been ascertained by photographic and photometric experiments, it is possible that some slight change may yet have to be made, even with high flames, in the hitherto received positions of the foci for the lens and prisms. For a fountain lamp this height should probably not exceed 14 mm. or 5 in. Fresnel places the foci for *upper* prisms in 1st order lights 28 mm. above burner, and the foci for lower prisms at points between 38 mm. and 68 mm. above the burner so as to clear the burner and wick.

Other circumstances of importance must also be taken into consideration in placing the foci. It is said to be highly inconvenient to have prisms which throw out *converging* rays, because among other matters the practical adjustment of the prisms is much embarrassed thereby, and it is recommended by Mr. Chance to endeavour to give the prisms a slight *divergence*† by slightly flattening the curved side of the prisms.

Fig. (2)

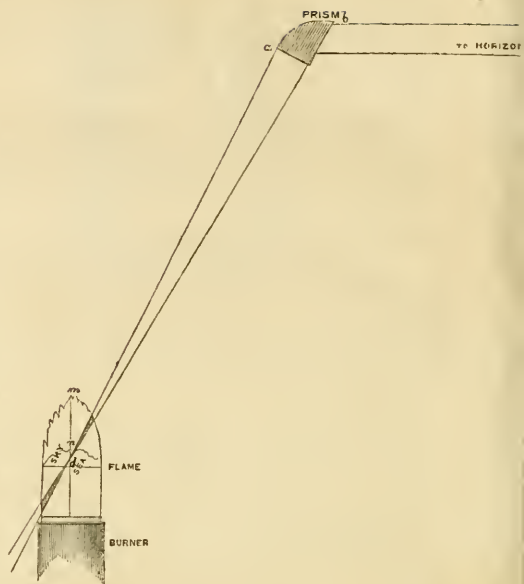
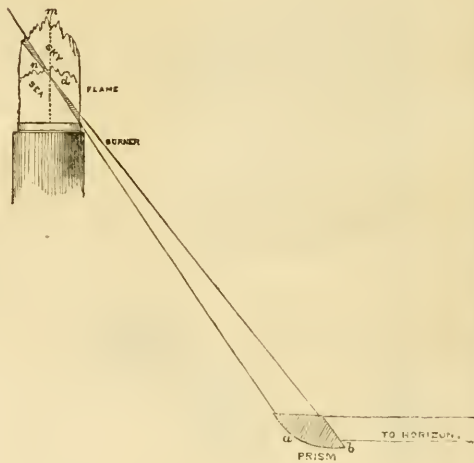


Fig. (3)

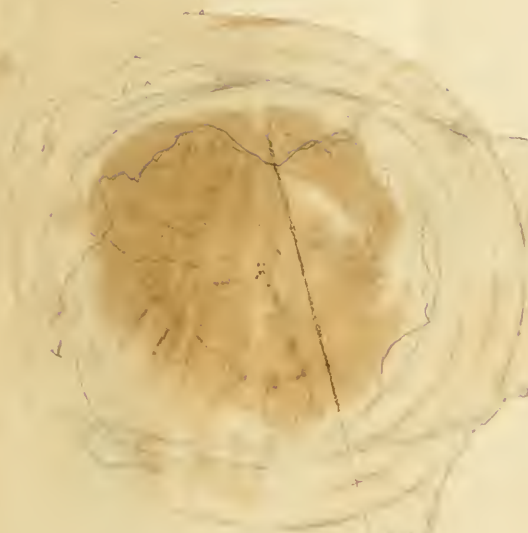
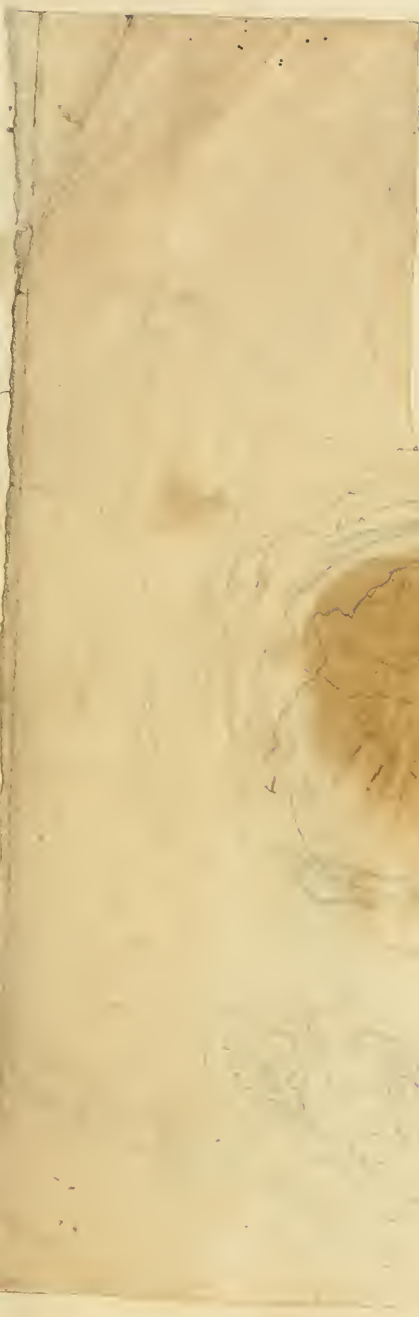


This would ensure all rays from luminous portions of the flame, after leaving the prism, becoming slightly divergent. Mr. Chance is still continuing his experiments on this interesting subject.

All these very important questions regarding the position of the foci depend upon the primary decision as to the relative importance of sending rays from the *brightest* portion of the flame to the *horizon*, compared with illuminating the sea within the horizon by an equal distribution of the rays through the angle.

* Until lately no great attention has been paid to any accuracy in giving this curvature. M. Suter admitted this. At North Foreland we found the focus of one of his prisms was 11 in. outside the flame, and this owing to the erroneous curvature.

† When a prism is found to have a more than usual amount of divergence, but yet not sufficient to cause its rejection, it should be adjusted, Mr. Chance suggests, so that the upper edge of the divergent beam goes to the horizon, otherwise some of the rays will be unnecessarily wasted in the sky.



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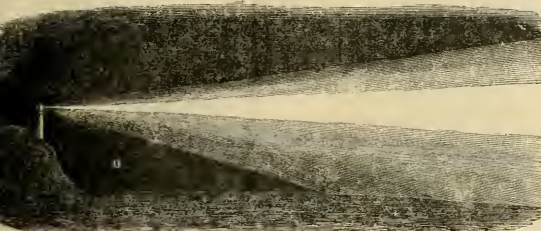
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Popular illustrations of the various methods practised and proposed of distributing the rays of light from the lens of a dioptric illuminating apparatus.

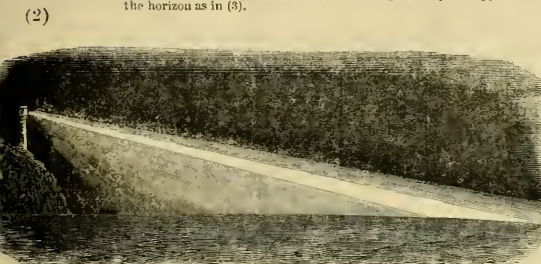
(1.) Present system (erroneous), centre of brightest beam directed to *geometrical horizon*.



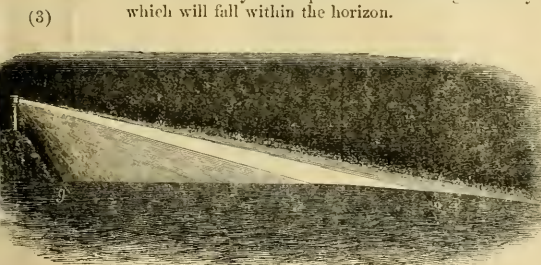
(2) and (3), *optional* (but not hitherto intentionally adopted in dioptric lights in the United Kingdom.)

(2.) Directs centre or upper edge of the brightest beam to *visible horizon*, and in so doing necessarily wastes some rays on the sky.

Note.—In Scotland, owing to the great height of the flames it is probable that the section of greatest luminosity is so high in the flame as to correct, in some instances, the ill effects that would otherwise have been occasioned by neglecting the dip; but this is only an accidental correction, and it may be overdone, and the brightest rays be dipped below the horizon as in (3).



(3.) Seeking to utilize *all* the rays, the horizon will necessarily be deprived of the brightest rays, which will fall within the horizon.



Note.—It will not be safe to draw rapid conclusions from the above sketches (2) and (3).

The danger arises from the great exaggeration in the height of the lighthouse and the size of the illuminated angle, which tends to bias the reader in favour of (3), whereas if the sketches were truly drawn to scale, the angle reduced to 6°, and the light's height above the sea reduced to its proportionate altitude, the merits of (2) would become more evident, and those of (3) less evident.

If paramount importance is attached to sending to the horizon the brightest rays that pass through the lens, rays from the *lower* portions of the flame as the beam is inverted *must* be wasted and sent above the horizon. If paramount importance is attached to utilizing all the rays, very few rays need be wasted, and yet, after mature consideration, the opinion will probably be unanimous, that notwithstanding the waste of rays it is better, in the great majority of cases, whatever the loss, to ensure that the horizon shall receive the brightest rays. It must never be forgotten that one great use of Lighthouses is to passing ships who deviate perhaps, considerably from

their course to sight the Light (made out perhaps 30 miles off from the mast head) and then immediately resume their course. Any diminution in the brightness of the ray sent to the horizon would be a serious injury to such vessels.

The great and increased importance of maintaining a *high* flame in *thick weather* is probably not sufficiently understood by lighthouse keepers, and should be impressed upon them. A high flame requires constant watchful care, and can only be maintained by an increased expenditure of oil. This accounts for the great disparity in the expenditure of oil in 1st order lights in England and Ireland when compared with the expenditure in French and Scotch lights.

The Scotch and French Lighthouse Authorities insist on the maintenance of a high flame, and insist on the consumption of that amount of oil which they know by experiment is necessary to maintain a high flame. Their consumption is nearly 70 per cent. larger than the consumption in an English or Irish 1st order light under the Trinity House. This very important subject requires evidently to be studied with much greater attention in the English and Irish first order lights, all of which ought to be supplied immediately with mechanical lamps, and a certain maximum consumption per hour should be insisted upon.

Since our last visit to Whithy, on which occasion we found that the mechanical lamp had been, in consequence of our first visit, substituted at the South Lighthouse for the fountain lamp, the North retaining the fountain, we have obtained two returns, one, the observations of passing mariners, and another a return from the Trinity House, giving the daily consumption of oil at both Lighthouses for many weeks. To our great surprise we found that the mariners gave a much slighter preference to the South Light over the North than had been expected considering that with a mechanical lamp the flame can be maintained at a much greater height, although at a considerably increased consumption of oil. Our surprise at this disappointing evidence ceased when we found, on reference to the Trinity House return of consumption of oil, that the keeper in charge of the South Light had, either through ignorance or intentionally, constantly consumed only the same amount of oil in his new mechanical lamp as the keeper in charge of the North Light in his old fountain lamp; the average consumption per year will, unless some change is made, remain, therefore at the South Whithy not more than 400 gallons instead of more than 700, which is consumed in Scotland and France, and the flame remain as low and therefore as ineffective as before. We found that the Elder Brethren had apparently taken no notice whatever of this ignorance or neglect on the part of the keepers at the South Whithy, and we can now understand what had hitherto puzzled us, viz., why the mechanical lamps were condemned by the Elder Brethren many years since. There can be no doubt that a mechanical lamp is an expensive, troublesome, complicated instrument if it is used, as at the South Whithy Light, for the purpose of consuming only a small amount of oil, (one gallon in seven or eight hours,) and creating a flame of about two inches, which can be effected just as well by the common fountain lamp; while it is an invaluable and (for the benefit conferred) an economical instrument if its powers are properly developed, to consume one gallon in less than five hours, and create a flame of from three to four inches.

IV. Central Wick.

The next point to be remarked on is the absence of the *fourth or central wick*. The French always have a fourth wick in their first order lights, and at the North Foreland and South Whithy the Trinity Board have just redopted them with the mechanical lamp. If rays only originated from the outer surface of a flame, and did not pass through the flame, it might at first sight appear unnecessary to pay any attention to the central portions of the flame, but it is well known that the pencil of light passing from a flame in any given direction varies in intensity

with the depth of the luminous section or portion of the flame from whence it has emanated. The external flames, like other flames, are transparent, and the light from the central wick passing through them sensibly increases the quantity of effective light. The omission of the central wick enfeebls, so to speak, the central portions of all these sections, and reduces the amount of light proceeding in all directions.

V. Burner and Lamp.

There was no means of adjusting the height of the lamp burner, or of correcting any lateral error.

The burner at the North Lighthouse was $\frac{1}{8}$ th of an inch out laterally, and also vertically as regards the geometrical horizon. It might be advisable to instruct the light keeper how to adjust the position of the lamp burner as is done in France, and the lamps ought to be fitted with the means of ready adjustment, small screws should be placed in the framework (as in Mr. Chance's), from which, when two lines are stretched across, their intersection should cover the centre of the burner; the keepers should test this occasionally, and report any error, and should be exercised, when inspected, in shifting lamps. In France the mechanical lamps are replaced by the spare lamps every three weeks, to ensure the pumps being kept in good working order.

VI. Lenses.

In the southernmost lens in the North Light the focus of divergency, the rays from which, when collected by the lens would pass to the horizon, was about half an inch higher in the flame than the other lenses. As the flame was at its best very low, this lens was probably of very little service. Mr. Masselin could not account for this. It arose, he thought, either from the curvature being faulty or the glass having a different refractive power; but M. Sauter suggested another reason, viz., that the workmen who ground the edges of the lens had taken too much off one edge, and in securing the lens in the frame had misplaced it. The error was so evident, that Mr. Masselin, Mr. Chance's foreman, was asked how it was that it had not attracted his attention when he was erecting it at Whitley? He stated that although he had expressed a wish that the lanterns should be first finished, his wish was disregarded, and he was obliged to erect the illuminating apparatus while the lantern was being built, both operations being carried on under a cover, which prevented the horizon from being visible, otherwise he would have detected the erroneous lens.

VII. Lower Prisms.

The Lower Prisms sent all their rays to the sky, none to the horizon or sea.—This most extraordinary fact was detected in the first place by the Astronomer Royal, and its truth was confirmed by all of us; the only prisms that sent their rays even to the geometrical horizon level were those of one section of the prisms of the North Light, occupying only a very small portion of the circumference, and they could only be seen from the direction of the South Light.

Mr. Chance states that this error has arisen from his having in these Lighthouses attempted *strictly* to carry out Fresnel's rule as to the height of the foci for the lower prisms, a rule which he now finds to be in considerable error in first order lights, although correct for the third order.

There is no doubt that there are 1st class dioptric Lighthouses that send rays to the sea through their lower prisms—Girdleness for instance in Scotland—specially examined and tested by the Astronomer Royal to ascertain this, and also all the Lighthouses we inspected in France. Mr. Chance assumes that this may be accounted for by their having been *practically* adjusted (without any reference to Fresnel's rule), by so fixing the lenses and prisms that the optical image of the horizon formed by each falls upon the brightest part of the flame. Mr. Chance *now*, since his attention has been drawn to it, practically adjusts all the lenses and prisms, irrespective of Fresnel's rule.

It is evident that all first order Lights, and in fact all dioptric Lights hitherto erected in the United Kingdom should, as early as possible, be visited by

competent persons, and the fact of the well or ill adjustment of all their lenses and prisms be ascertained, and any errors found corrected. The Astronomer Royal estimates that this could be effected in about two years if one person only was employed.

The Trinity yacht conveyed the Royal Commissioners at night to a distance of from four to five miles from the Whitley Lights, when, by a preconcerted signal, the central lenses of the North Light were covered, and it was then satisfactorily shown to the Elder Brethren by the aid of telescopes that there was no light in the lower prisms.

No light came through the lower prisms of the South Light, either.*

[The lower prisms at the South Whitley have now been adjusted, a very slight change in the position of the prisms was sufficient to effect this important object.]

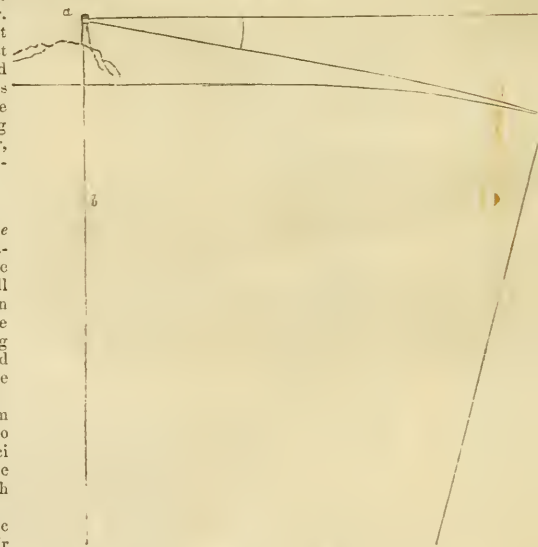
VIII. Upper Prisms.

The Upper Prisms were sensibly out of adjustment. Mr. Chance's foreman, when seeking for the horizon in these upper prisms, by the method suggested by Mr. Campbell, our Secretary, detected some errors of adjustment in them. These prisms have since been readjusted.

IX. Platform.

The Platform or Table was out of Level. The illuminating apparatus has hitherto been placed on one central iron support—this may in course of time settle or give, which would throw out the action of the illuminating apparatus very considerably. At Girdleness the platform is supported at its circumference by a series of inclined or zigzag roads; this method of support appears greatly preferable to that by central columns. The maintenance of correct levels should be ascertained from time to time by means of a spirit level.

X. *Adjustment of Lenses and Prisms for the height of Light above the sea.*



As, owing to the curvature of the earth the visible horizon is below the geometrical horizon, the rays intended for the visible horizon ought to be dipped through that angle—this angle will increase with the height of the Lighthouse. *d* is the geometrical and *c* the visible horizon, and *d, a, c*, is the angle of dip.

Now that the glass can be made very clear, free from veins, and therefore non-divergent, and great

* During the day, on looking at the South Lights, lighted for the purpose, from the gallery of the North Light, also from a window at its base, no light could be seen in lower prisms, it was only seen from the top of the lantern of the North Light, considerably above the horizontal direction.

1. **Identify the problem.** The first step is to identify the problem or issue that needs to be addressed. This involves understanding the context, the stakeholders involved, and the specific goals and objectives of the project.

2. **Analyze the problem.** Once the problem is identified, the next step is to analyze it. This involves breaking down the problem into smaller, more manageable components and identifying the root causes of the problem.

3. **Generate solutions.** The third step is to generate potential solutions to the problem. This involves brainstorming ideas and evaluating them based on their feasibility, effectiveness, and potential impact.

4. **Implement the solution.** Once a solution has been selected, the next step is to implement it. This involves developing a plan of action, allocating resources, and executing the plan.

5. **Evaluate the results.** The final step is to evaluate the results of the project. This involves measuring the progress of the project, assessing the impact of the solution, and identifying any areas for improvement.

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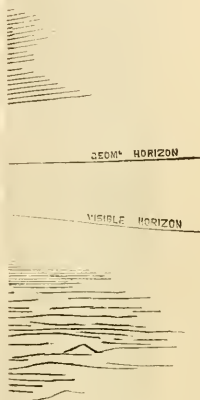
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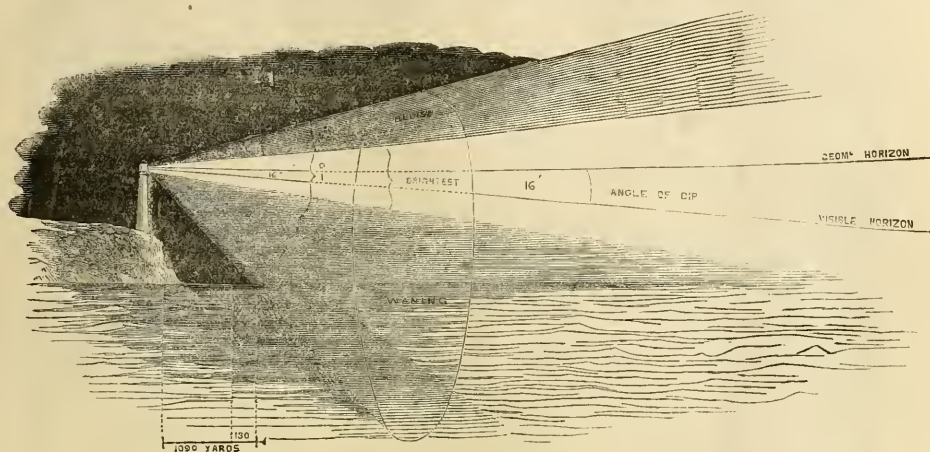
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Diagram showing approximately the effect produced on the light transmitted through the *lens* of a first class dioptric light by neglecting the dip.



N.B. The size of the angle is exaggerated to make the effect more evident.

accuracy can be attained in the shape of the prisms and lenses by the cross-action in polishing them, this angle of dip cannot be ignored without unnecessarily sending a considerable amount of light to the sky; and the higher the Lighthouse the more light is wasted in that direction. The necessity of taking the dip into consideration is increased, if at one and the same time, as in England and Ireland, the burner has been placed with regard to the focus of the lens in the position pointed out by Fresnel (viz.: for 1st order dioptric 28 mm. or 1.1 in. below the focus), and the flame is, or may be expected to be, lower than the high flames created in Scotland and France. The section of intensest luminosity is only that height, (1.1 in., above the burner) in very high flames, and is much nearer the burner in low flames, such as those produced in England and Ireland by the fountain lamp.

The burner appears to have been placed originally at the above distance below the focus in England and Ireland, whatever may be the height of the light above the sea, and notwithstanding the use of the fountain lamp. The horizon, therefore, in such case takes the larger portion of the light that reaches it through the lens from sections having their inter-

the eye is placed in the proper position when any lens or prism is being adjusted. It is by no means an easy operation, except for a person accurately acquainted with optical science, to readjust the prisms after they have been erected in the Lighthouse, and it should not be attempted, except by an optical engineer, for this evident reason that raising or lowering the lamp has opposite effects in the lens and in the prisms, and every prism must be moved. This was effected at the South Whithy under Mr. Chance's personal superintendence.

But it may be asked what injury would have been done (1), to the illumination of the horizon, and (2), to the illumination of the sea by neglecting the dip, as has been done in the United Kingdom and France, if the flame is maintained at its proper height, as it is in Scotland and France by the use of the mechanical lamp; and this question has a direct practical bearing on the case. The readjustment of all the prisms is a serious matter. Take this case, viz. a light 240 feet above the sea, as at Whitby, (an unusual height in the United Kingdom, where atmospheric difficulties unknown in the Mediterranean interfere to prevent the selection of great heights), and let us suppose that the lamp there used had been the mechanical, and the dip neglected. At the height of 240 feet the

Royal Commission,
Light, Heat, and Power,
Mr. William B. Street, P. M.
London.

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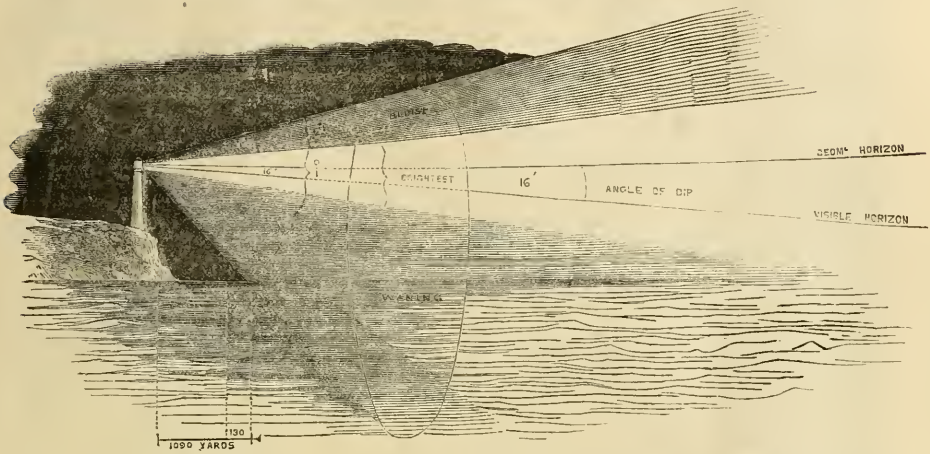
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the eye is placed in the proper position when any lens or prism is being adjusted. It is by no means an easy operation, except for a person accurately acquainted with optical science, to readjust the prisms after they have been erected in the Lighthouse, and it should not be attempted, except by an optical engineer, for this evident reason that raising or lowering the lamp has opposite effects in the lens and in the prisms, and every prism must be moved. This was effected at the South Whitty under Mr. Chance's personal superintendence.

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First, the Lens.—The beam passed through the lens is inverted. Its brightest portion occupies about say 1° of the angle, the remainder being divided in the following manner, see diagram, the lower edge of the divergent beam will, in such a case, if the angle is 6°, and the height of the light above the sea 240 feet, strike the sea at 1090 yards distance from the base of the Lighthouse (within that distance no direct rays will reach the hull of a vessel through the lens). The dip due to the height of 240 feet is 16'. If the brightest beam derived from the section of intensest luminosity has a divergence of more than 32', without any sensible decrease of intensity, then the horizon will be illuminated by rays from the brightest portion of the flame, and will not, as far as the lens is concerned, have suffered by the light not having been dipped; but even supposing that owing to the equable intensity of luminosity extending over a portion of the flame sufficient in size ($\frac{1}{2}$ of an inch) to enable the horizon to be lighted from the brightest part of the flame though the light has not been dipped, it is evident that the sea within the horizon must soon begin to suffer, for there can be no doubt that the upper portion and not the lower of the beam of greatest intensity should be directed to the horizon, as in the former case the remainder of the section of greatest luminosity will illuminate the sea instead of (as in the case of the light being undipped) going to the

* The plan proposed in Mr. Stevenson's work, viz., to cant or tilt the lens, is erroneous, as tilting the lenses only distorts the image; it does not move it in altitude.

Even if tilting had the stated effect, it would be very undesirable to give the keepers power to tilt the lenses.

sky. It is the sea then, rather than the horizon, that is most injured (as far as the lens is concerned) by neglecting the dip. At first sight we are inclined to suppose that neglecting the dip may be very injurious to the very near ships, but when a calculation is made (see table, p. 101), it is readily seen that dipping, in the above case, through the angle of $16'$ will only light up an additional narrow strip of the sea, about 130 yards broad.

To sum up, therefore, the effect of not dipping as far as the *lens* is concerned, when the mechanical lamp is in use, and the *flame is of the proper height*, the effect is—(1) *perhaps* to slightly injure the illumination of the horizon; (2) *certainly* to injure materially the illumination of the sea within the horizon; and (3), to exclude from direct rays a very narrow strip of sea near the lighthouse.

Upper Prisms.—Neglecting the dip is a maladjustment of the prisms, and has this effect, that the light which reaches the horizon is taken from a more advanced section of the flame, reducing thereby the size of the portion of the flame which illuminates the sea, diminishing therefore the total light sent to the sea through each prism, and probably transferring the position of the focus for parallel rays for each prism to a less bright section of the flame.

N.B. If the lamp, supposed to be a mechanical lamp with a high flame, is raised to dip the rays passing through the *lens* from the brightest section to the visible horizon, then the original error in the adjustment of the *upper prisms* is doubled, and great care will be requisite in deciding upon how far it is safe to raise the lamp. At Girdleness, Professor Airy, for this reason, recommended that the lamp should only be raised through half the angle of dip. In England and Ireland, until the mechanical lamp is substituted for the fountain, another element of disturbance enters into the question, and no imperfect adjustment should be attempted.

Lower Prisms.—So small in altitude is the portion of the flame which the interposition of the edge of the burner allows to send rays to the lower prisms, and so narrow therefore the emitted beam and so small the divergence, that a neglect of the dip will very possibly deprive the horizon and the sea of any rays from the lower prisms, as we found to be the case at the Whitby lights, where the lower prisms sent all the rays that passed through them to the sky.

N.B. As the portion of the flame which will send rays below the horizon to the sea, is that portion between the direction of the axis of parallel rays and the edge of the burner, any attempt to raise the lamp, in order to dip the brightest rays through the *lens*, unless the lower prism are also readjusted, will probably bring the axis of parallel rays into the burner, and then immediately the lower prisms will cease to illuminate either the *sea*, or the horizon, even if the latter had previously received some few rays.

It is right to state here that rays from the sides of the flames may still be effective.

Neglecting the dip, therefore, when the flame is high, unless the height of the light above the sea is considerable, does possibly no great harm to the effect of the *lens* at the horizon, but it diminishes the light sent through the lens to the sea, and it lessens the amount of light sent both to the horizon and the sea from the *upper prisms*, and lessens if it does not entirely prevent the transmission of any light to the sea, and perhaps also to the horizon through the *lower prisms*.

In the case of the electric light, where the dimension of the luminous body is only about $\frac{1}{8}$ of an inch, and the divergence is therefore very small, it is of the last importance that the rays should be accurately dipped and directed. In the case of the oil lamp with a flame of 4 in., and a divergence of 6° for reasons stated above, the question is comparatively of less importance, *provided always that a proper flame is maintained*, but as there is no difficulty in adjusting the lenses and prisms for the given height, it should never be neglected, as careless keepers may neglect to keep a high flame. Very careful experiments to measure the intensity of different sections as seen from lenses and prisms should be made.

XI. Glass.

We noticed that the glass of some of the prisms at Whitby was streaky and wavy. Since that glass was cast Mr. Chance informs us he has effected a great improvement, by melting the glass in covered pots. Some glass since produced is quite free of streaks, and of a very good colour.

XII. Reflectors in Land Angle.

In the North Whitby Light there were no catoptric reflectors on the land side of the illuminating apparatus. There were reflectors in the South Lights (but they were badly figured). This would afford a good opportunity of testing the value of the catoptric reflector. In its absence, about $\frac{1}{3}$ of the light, viz. that in the land angle, is entirely lost and wasted.

XIII. Filter for Oil.

The oil is not filtered in the English Lighthouses. The filtration of the oil in the French Lighthouses is part of their judicious treatment of the science of illumination; the greatest care being taken to measure the quantity consumed in every hour, or during each watch or guard; and the great and natural anxiety of the keepers to maintain a perfect flame, precludes the possibility of the unconsumed oil that remains in the lamp in the morning, partly soiled and injured by its contact with the flame, being allowed to form part of the oil at the commencement of the next night; it is therefore carefully removed, but before being returned to the general reservoir it is necessarily carefully filtered. Filters should be introduced in all our Lighthouses.

XIV. Distinctive Character of Lights.

The Whitby Lighthouses are both of the first order, and therefore of the most expensive character. They cost, when completed, 5,256*l.*, and they will, with high flames, cost for maintenance about 800*l.* per annum. 800*l.* per annum at 4 per cent. represents a capital sum of 32,000*l.*, which added to the primary cost, viz., 5,256*l.*, makes the total cost of the Lighthouses 37,000*l.* If the second Lighthouse is unnecessary, and sufficient distinction could have been given to one Lighthouse the large sum of 18,500*l.* has been wasted. The direction of the rock is sufficiently pointed out by the red cut off.

XV. Relative Height of the two Lights above the Sea.

The Lights have been placed so as to point out the line of direction of a danger off the harbour. That two Lights, if intended to be used as a leading mark to clear a danger, should be of unequal height, one being higher than the other by a number of feet depending upon the distance of the danger and the horizon, it might have been thought, an axiomatic truth in Lighthouse engineering, and, if to gain this object, it had been found advisable to have the buildings much closer together, economy in various ways would have been studied. The reason why such Lighthouses should be of unequal heights is, that when of the same height (as at Tuishowen) it is impossible to know when they are slightly open, whether it is the nearest or the most distant that is to the right or left, a very important point in intricate navigation. At Whitby, the light in the north Lighthouse turns to red when the lights are in one, but in some states of the atmosphere it is difficult to distinguish white from red.

XVI. Height of flame of the mechanical lamp in the South Lighthouse.

On our second visit we found a mechanical lamp at work in South Lighthouse, and all the upper and lower prisms readjusted. Various experiments were tried (see Mr. Faraday's report), but it is necessary to observe that the experiments cannot do justice to the mechanical lamp, for, as exhibited in the South Lighthouse on that occasion and since, it did little credit to the principle.

The Lighthouse keepers were inexperienced, could only succeed in burning one gallon in six or seven hours, instead of in less than five, as in Scotland, or as in France; and on the night of the sea experiments, when we were disappointed at the South Light not

showing to greater advantage, it was ascertained from Mr. Chance that the nature of the programme (which, instead of being entirely a time programme, as was suggested, involved constant looking out for the ship's signals, and therefore frequent opening and shutting of the gallery door), injured the draft, and therefore the flame, which was not improved by the presence of additional keepers in the lantern. Mr. Chance stated that he had to change the chimney twice because it got smoky; to trim once, and that he observed the flame was (strange to say) brightest when the overflow was least, all proving that the flame was in anything but a satisfactory state.

The necessity of maintaining always a *high flame* of 4 in. must necessitate constant watch and guard on the part of the keepers, and this again frequent visits on the part of inspectors. In France the inspectors have a master key, so that they can visit at unexpected moments. Commanders and Lieutenants of Coast Guard are perhaps the persons in the United Kingdom who could most satisfactorily perform this duty.

It would only be necessary for them without any warning to enter the Lighthouses, measure the height

of the flame, and report it next morning, with any remarks on the watchfulness, or otherwise, of the keepers. They should not have the power of interfering in any other manner, or of giving any orders or instructions.

XVII. *Site*.—Owing to the height (240 feet) of the lights above the sea, they are frequently obscured by clouds. It admits of considerable doubt whether one lighthouse about 120 feet in height on an outlying rock would not have been more efficient and less expensive in the long run.

It will be seen by reference to the Astronomer Royal's Report on his visit to Whitby that he estimated the waste of the small quantity even of light that was afforded by the old fountain lamps then in use as very considerable, owing to the various errors he alludes to, leaving only a small portion of the light, estimated by him as one tenth really useful. Now that a mechanical lamp has been placed at the South Whitby Lighthouse, and all the lenses and prisms have been carefully readjusted by Mr. Chance, the light and brilliancy ought to have increased most considerably; but this desirable result awaits the proper management of the lamp and an increased consumption of oil.

The above remarks on the errors and deficiencies at Whitby have been submitted to the Astronomer Royal, the Commissioners being most anxious neither to overstate the number of errors nor to attach too much importance to any one of them.

Professor Airy after carefully considering them, has been pleased to state that "he believes the above statements as to the errors and deficiencies at Whitby to be perfectly accurate."

INVESTIGATIONS PROPOSED BY DR. GLADSTONE.

Production of Light.

1. The relative light-producing power of different oils and hydrocarbons, both liquid and gaseous, such as colza oil, olive oil, seal oil, porpoise oil, benzine, paraffine, belmontine, camphine, coal gas, oil gas, gas saturated with vapour of naphtha, in reference to the quantity burnt. Each of the combustibles must be burnt to the greatest advantage, and hence may require a particular kind of lamp.

This was done in reference to sperm and colza oil before the change was made by the Trinity House.

2. The relative light-producing power of the lime light as produced by hydrogen and oxygen, or by coal gas and oxygen, and with various forms of apparatus; also with caustic lime and various compounds of lime; and, indeed, with the substitution of magnesia, alumina, or other earths in place of lime. These should be referred to some standard by which they may be compared with the combustibles mentioned in the previous paragraph.

3. Analogous experiments with electric lights. Different forms of galvanic battery, or electro-magnetic machine, different kinds of charcoal points or other material to become luminous, different forms of regulator, &c., must be considered.

4. As the power of penetrating a mist is not always directly proportional to the amount of light emitted through a clear atmosphere, the above experiments ought to be repeated in a mist.

5. The relative advantages and disadvantages of these several combustibles and means of producing light in regard to expense, tendency to smoke, effect of temperature, effect of irregular draughts, liability to explosion or other accidents, portability, room required for machinery, &c.

Utilization of Light.

6. The amount of light lost in reflection from polished silver, copper, glass coated with mercury, glass covered with silver by Petitjean's process, by Liebig's process, &c. This must be determined for various angles.

Professor Potter has made some experiments with reference to this question.

7. The amount of light lost in transmission through glass of various composition. This is a composite phenomenon, depending partly on absorption, which will differ with the thickness of the glass, and partly on reflection from each surface, which will differ with the angle at which the ray enters the glass, and the angle at which it emerges from it. All these circumstances must be considered.

Professor Potter has also made some experiments in this direction.

8. How far the above results depend on the intensity or character of the light itself.

9. Whether polarized light, such as must be produced where light passes through glass surfaces at high angles, is as capable of penetrating a mist as unpolarized light is.

10. The relative value of different parts of the flame to different pieces of optical apparatus.

This was attempted in a previous paper of mine, at least as far as the ordinary dioptric arrangement for a fixed light is concerned. (See p. 73.)

11. Whether a flame is perfectly transparent to its own rays.

Count Rumford determined that it is; but the fact recently recognized, that certain flames absorb light of the same refrangibility as they emit, would indicate that more minute experiments might show that it is not perfectly transparent.

12. The relative luminosity of different sections of a flame taken horizontally and diagonally at various angles. Flames of all the different sizes and characters actually used in lighthouses should be examined.

This experiment it is proposed by the Commission to perform, at least as far as regards a 1st order lamp.*

When all these questions are determined, it will probably be simply a matter of calculation to determine the five following points:—

13. The relative merits of parabolic metallic reflectors, and optical apparatus made of glass alone.

Various computations have been already given by Mr. Fresnel, Professor Potter, Mr. Alan Stevenson, and others, but more complete data are desiderated.

14. The angular limits in the vertical plane, within which it is desirable to employ a lenticular arrangement; and where a system of totally reflecting prisms becomes more serviceable.

15. The most advantageous form for the totally reflecting prisms.

It is possible that, as suggested by Mr. Campbell, if the surface by which the ray enters and that by which it emerges were at right angles to it, it might cause a saving of light, notwithstanding the longer space of glass which the ray would then have to traverse.

16. The most advantageous position for each separate piece of optical apparatus.

The Commission have already given this matter much consideration, but the data do not yet exist for a complete determination.

17. Through how large an angle in the vertical plane the divergent beam proceeding towards the horizon from a given lamp-flame, and with a given optical arrangement, may be considered practically uniform in luminosity.

18. The influence of different forms of the shoulder of the lamp glass on the direction of the emitted rays.

* As Messrs. Chance performed experiments with this object, which were subsequently inspected by the Commission, (see p. 61.) they considered it unnecessary to carry out their previous intention.

19. What kinds of glass are least affected by weather or sudden changes of temperature.

20. The influence of different forms of lamp glass on the draught. Lamp glasses may and do differ in having the shoulder at different heights, shoulders of different forms, or no shoulder at all, and in having cylinders uniform in width, tapering, or trumpet-shaped, and in their width and height; or they may be globular, pear-shaped, &c.

21. The influence of other parts of the apparatus on the draught, viz., the continuous metallic chimney, which may be wider or narrower, longer or shorter, straight or bent, uniform or otherwise in width, &c.; the wick holders, which may be thicker or thinner, more or less wide apart, &c., the central button or open space, &c.

22. The best means of preventing irregularities in the supply of air, and in the rapid removal of the products of combustion during gusty weather.

23. The amount of overflow of oil, which is conducive to the burning of the largest quantity of the said oil in a given lamp.

24. The most simple and trustworthy means of producing this overflow with regularity.

The French appear to have experimented much on this and the previous question.

25. How to secure the requisite strength in the astragals or other framework of the optical apparatus and lantern with the least possible interference with the light.

26. The amount of heat rays reflected back by mirrors of various kinds. This need be considered only when the rays strike the mirror at right angles to its surface.

27. How far a flashing light has the advantage in catching the eye of an observer at a great distance, irrespective of its intensity. As this is a subjective phenomenon it will differ with different observers.

Some experiments now in progress by Professor Swan which bear on this subject are alluded to in Sir J. Herschel's evidence (see Vol. II, page 595).

Colour.

28. The relative space-penetrating power, either through a clear or a misty atmosphere of rays of different refrangibility, and consequently different colour.

Sir D. Brewster's observations, and mine, on the Beachy Head Light (and elsewhere) have to a great extent determined this. Messrs. Reynaud and Degrand have also published a paper on the power of the red ray to penetrate to great distances.

29. The particular rays transmitted by different coloured glasses, and how far this is affected by heat. As the same nominal colour may be produced by different means, for instance red glass by copper or by gold, glasses of these different compositions must be examined. As the thickness of the medium or the depth of the colour most materially influences the absorption, this should be determined for various thicknesses.

This has been partially done by Sir J. Herschel, myself, and others.

30. The most efficient and easily applied means for enabling an ordinary colour-blind person to determine the colour of a flame seen by him at a distance.

31. How far does the different power of irradiation or diffraction cause one coloured light to be more visible than another, either through clear or misty atmosphere, the intensities being equal.

32. Whether there is any subjective cause tending to the more ready perception of some particular colours.

33. Whether coloured lights can be advantageously produced by bringing certain salts, or other substances, into the flame of the lamp; or by exposing baryta or strontia to the oxy-hydrogen flame, in place of lime; or by steeping the charcoal points of the electric lamp in similar salts.

34. Whether a larger amount of coloured light might be obtained by making use of a portion of a beam prismatically dispersed than by reducing it by absorbent media.*

* Sir David Brewster, in his reply to the scientific questions, received since this was written, suggests other means of obtaining the same object.

Fog Signals.

35. The manner and degree in which fog absorbs or destroys sounds of different pitch.

36. The manner and degree in which fog absorbs or destroys sounds of different characters; for instance, a sharp sound or a prolonged sound.

37. A comparison of the various means of producing loud sounds, as to their pitch, volume, convenience, costliness, &c. The bell, gong, gun, drum, horn, whistle, &c. must be considered.

38. Whether there are any reasons existing either in nature, or in the human mind, which render more perceptible a repetition of the same sound, or some variation in note, octave, frequency, &c.

39. The influence which the height above the sea, at which the sound originates, has upon the distance at which it is audible in fog.

40. The influence of a background, such as tower, a cliff, or a hill, in reflecting sound.

41. The best means of directing a sound in a particular direction.

42. The best means by which the direction of a sound may be approximately determined by a listener on board ship.

Buildings.

43. The relative durability of different kinds of stone, slate, brick, composition, cement, metal, and other building materials, when exposed to sea water or seaspray, as well as the ordinary influences of wind, sun, and rain. The relative costliness and ease of working will depend much on the site.

44. The same in respect to different kinds of paint and other colouring materials.

45. The best form for resisting the force of the waves, the building being solid.

This was determined by Mr. Alan Stevenson to be a hyperbolic curve.

46. The best form and arrangement of piles, so as to secure the greatest strength with the least resistance to the waves.

47. The best methods for maintaining a comfortable temperature in the lantern, watchroom, and keepers' houses.

48. The most convenient, trustworthy, and inexpensive methods of producing a continuous movement for revolving apparatus, working fog signals, &c.

Altitude of Light.

49. The comparative amount of interruption in the visibility of a light by the upper, middle, and lower strata of ordinary showers.

The following inquiries are of a local character.

50. The ordinary height of the sea mists at or near the proposed site.

51. The influence of hills, and other geographical characteristics of the neighbourhood, on the production of clouds during prevailing winds.

52. The ordinary height at which these clouds are formed, or at which those borne by prevailing winds pass.

53. The height to which the sea spray rises at the proposed site during common gales.

54. The height to which dust rises under similar circumstances, and whether it is of a character that would attach itself to the glass of the lantern.

J. H. GLADSTONE.

The preceding list was first submitted on August 29th, with the exception of Nos. 19, 26, 34, and 49, which were added in December 1860, when also the following list was prepared.

ADDITIONAL INVESTIGATIONS having reference solely to FLOATING LIGHTS, BUOYS, AND BEACONS.

Action of Waves, &c.

55. The whole theory of waves in the open deep sea.

56. The manner in which the movement of waves is modified by tides or currents.

57. The manner in which the movement of waves is modified by the vicinity of land, either as a shore on one side, or shores on both sides, isolated rocks, or a bottom at no great distance from the surface.

58. The manner in which these modifying influences act and re-act on one another.

These questions are treated in some works on natural philosophy; but not so fully as might be desired, in any with which I am acquainted. If they were satisfactorily determined they would form a good foundation for the following inquiries:—

59. The form of vessels (for ships or buoys), which will maintain the greatest equilibrium under all or any of these circumstances.

Questions relating to the equilibrium of floating bodies have frequently been discussed both mathematically and practically, as by the Rev. W. Moseley, but not generally with reference to the nature of waves. Opposite opinions are expressed by eminent men in our scientific evidence.

60. Where the moorings should be attached to such a vessel, so as to interfere least with the maintenance of equilibrium.

On this point also there is contrariety of opinion among the scientific evidence.

61. The form of vessel (for ships or buoys) which will offer the least resistance to water under all or any of the preceding circumstances, when the vessel is moored.

62. Where the moorings should be attached to such a vessel so as to be subjected to the least strain.

63. The form of hull, masts, and rigging, least affected by high winds, the vessel being stationary.

64. The laws that determine the formation or shifting of sand banks under such circumstances as occur in nature; for instance, at the embouchure of a muddy river where the sea is shallow and exposed to strong tides.

Material.

65. The relative durability of different woods, iron in its various conditions, copper, "yellow metal," and other alloys, and of these covered with different paints, when exposed to seawater in rapid motion, air, and sun, and liable to the growth of *algæ*, and the attacks of marine animals.

66. The toughest description of iron for moorings.

This, I presume, has often been the subject of experiments; but as the presence of a small quantity of some other element will often alter the properties of iron considerably, experiments on new combinations, or on new descriptions of iron that come into the market, should be made from time to time.

Mechanics.

67. The most perfect mechanical contrivance, practically applicable to the lantern of a lightship, for maintaining it in the same horizontal position under every variety of motion.

68. The best form for the links of a cable, and for its fastening to a floating body, so as to ensure the greatest strength with a due regard to mobility.

69. The best form of anchor for different descriptions of river or sea bottom.

Indication of Buoys.

70. The relative merits of different colours, and of combinations of these colours for catching the eye, when the object so coloured is riding on the surface of the sea in thick weather, or on a clear night.

The mariners' evidence, and observations made by the Commission, establish that buoys of a dark colour are most apparent at night; but they do not decide between red and black, nor between plain and chequered or striped buoys.

71. Whether red paint, when the light incident on it is small, is distinguished with difficulty by ordinary observers from black paint.

72. The most available means of obtaining sufficient mechanical power from a tidal or other current to ring a bell, strike a gong, blow a whistle, or make any other effective sound.

Some suggestions are given in the scientific evidence.

73. The means best calculated to effect the same object in an almost motionless sea.

74. Whether any chemical means of producing light can be made available for the illumination of buoys or beacons washed over by the waves, and which sometimes cannot be reached for weeks together.

75. The relative intensity, expense, and security from accidents of different galvanic lights (as an ignited platinum wire, or the vacuum discharge in very narrow tubes.) The power may be produced on land, and conveyed by insulated wires, but the apparatus where the light is produced must require no attention for weeks together.

76. The most effective means for reflecting from a buoy or beacon under the aforesaid circumstances a light produced on shore.

J. H. GLADSTONE.

RELATIVE POSITION OF THE FLAME TO THE DIFFERENT PARTS OF A DIOPTRIC ILLUMINATING APPARATUS.*

An ordinary dioptric apparatus for a fixed light consists of lenticular zones, upper prismatic zones, and lower prismatic zones.

There are two objects sought:—

1st. To send the strongest possible light to the actual horizon.

2nd. To throw the strongest possible light on the sea between the actual horizon and the light-house, but especially near the horizon.

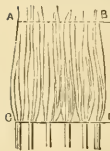
To fulfil both these requirements to their fullest extent is evidently impossible; they are antagonistic.

It becomes, therefore, a desideratum to determine their relative importance. This will differ with the site; but taking this into account, and the elevation of the apparatus, it would be easy to decide on a certain angle of divergence which the very bright beam should possess, taking care at the same time that a

small amount of light was allowed to fall between that divergent beam and the base of the lighthouse.

It is only necessary, in this instance, to consider a section of the flame.

If there were no apparatus at all, every luminous point in the whole flame A B, C D, would send its rays to an eye on the horizon, the said rays forming a cone, of which the luminous point is the apex and the pupil of the eye the base; and the farther the horizon is from the flame the smaller will be the divergence of this cone, and consequently the smaller will be the amount of light received by the eye. The whole of these rays which thus reach the eye on the horizon will be comprized within the beam A M, C N, the sides of which are approximately parallel. Any ray, from any part of A B, C D, which is directed above or below this beam, or which cuts either of its boundary lines B M, D N, will never reach the horizon.



* This is printed exactly as it was prepared for the use of the Commissioners near the commencement of our inquiries into the proper adjustment of the illuminating apparatus, and therefore before the discussions and experiments at Whitby and Birmingham. In the diagrams no attempt was made to represent the actual proportions of flame or glass work in use; and the whole must be taken simply as a scientific introduction to the subject—J. H. G.

1st. *The Lenticular Zones.*

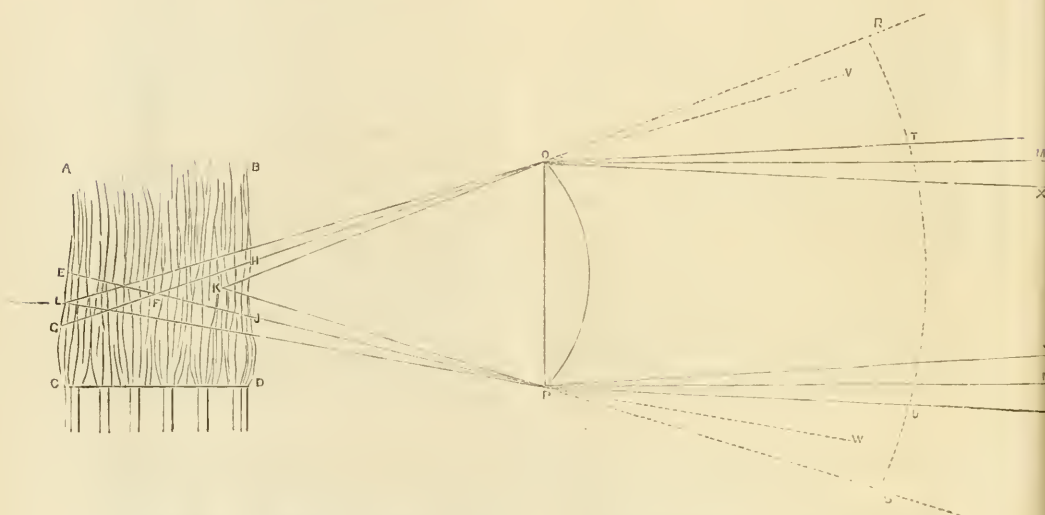
If now, a lens be introduced in the course of this beam, as at O P, it produces both a loss and a gain of light to an eye on the horizon, that is to say, some of the rays which formerly entered the eye are now

diverted from it, while other rays are brought to it. If F be the focus of the lens, answering to the eye on the horizon, no rays will enter that eye except from luminous points comprised within the double triangle E F G and H F I.



From the point F the whole of the divergent rays between F O and F P will be sent to an eye on the horizon. From any point K in the anterior triangle H F I a larger proportion of the divergent rays

between K O and K P will enter the eye on the horizon than if the lens were not there, for the lens contracts the whole divergence R S into a divergence only T U.



And similarly from any point L, in the posterior triangle E F G, a larger proportion of the divergent rays between L O and L P will enter the eye on the horizon than if the lens were not there, for the lens will contract the whole divergence V W into the converging beam X Y, which must have a focus somewhere, from which it will diverge again, but at an angle smaller far than V L W.

The nearer the points K and L are to the point F, the larger will be the proportion of the divergent beams from them that will enter the eye on the horizon.

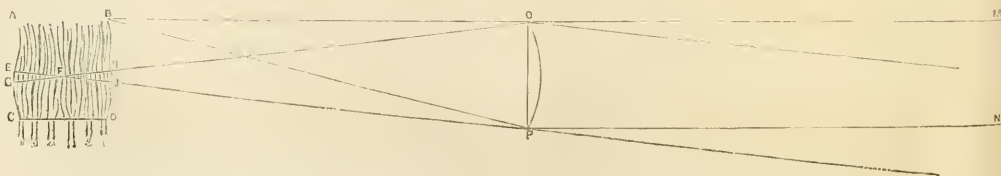
By placing the focus F in the anterior part of the flame instead of the centre, the following advantages will be gained:—1st, it, and the neighbouring points, which are so valuable for the horizon, will be situated in a very luminous, instead of a non-luminous part of the flame.

2nd. A larger section of the flame will yield light to the eye on the horizon.

3rd. This light will mainly converge between the lens and the eye, and hence will be more valuable.

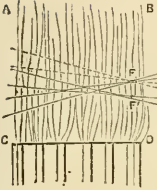
As far as the surface of the sea is concerned, the introduction of the lens in the path of the beam B M, D N, produces the following effect:—

1st. The divergence is made smaller, for the ray proceeding in the direction B P is refracted somewhat upward, though still below P N, and the ray B O is not refracted downwards so much as to be parallel with B P.



This sending of the rays further to sea will be generally an advantage.

2nd. The light sent to the sea is the whole of that emitted from A E F H B, (passing through O P), and half of that from E F G and H F I (with the exception of what goes to the eye on the horizon), instead of being half of that from the whole flame A B C D (with the exception of what goes to the horizon). This may be made an advantage by depressing F sufficiently.



and another portion to the sea, whereas without the lens, or some equivalent optical arrangement, all these rays would go the sky.

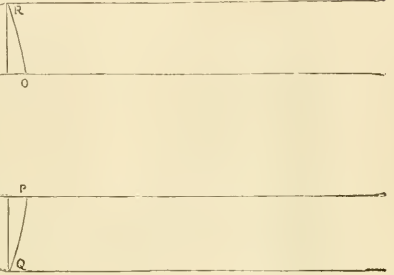
The lower portion of the lens P Q will cause a portion of the light that impinges upon it to proceed to the horizon, another portion will be directed to a more distant part of the sea than it would otherwise have fallen upon, while another portion which would otherwise have proceeded to the sea will be directed towards the sky. The parts of the flame which furnish these different rays will be easily seen by a reference to the preceding demonstration. For the reasons above given the focus F should be in the anterior portion of the flame.

To secure the advantage of throwing as little light up to the sky as possible by the lower portion of the lens, the focus might be advantageously placed at a lower point F', than that adopted for the central part of the lens.

3rd. The light will be distributed differently on the surface of the sea.

Hitherto that portion of the lenticular apparatus has been alone considered, which is interposed in the path of the rays proceeding directly from the whole flame A B C D, to an eye on the horizon; but practically the lenticular zones are extended above and below this.

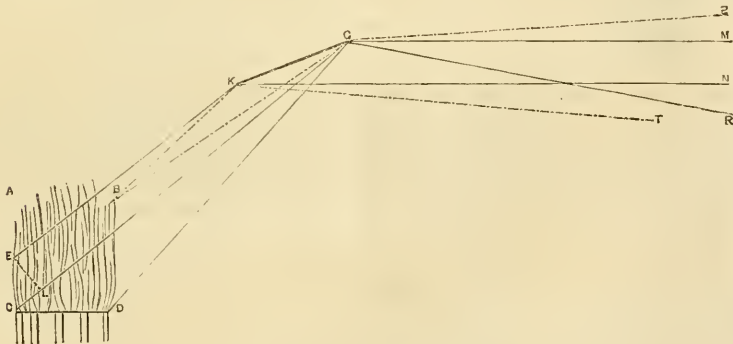
The higher portion of the lens R O sends a portion of the light that impinges upon it to the horizon,



2nd. The Upper Totally Reflecting Zones.

The reflecting surface of these prismatic zones acts as a mirror; and in the subjoined diagrams it alone is represented for the sake of simplicity.

If this surface be flat, it will send to an eye on the horizon such rays as impinge on the said surface from a segment of the flame. This beam, of which the sides are E K N and C G M, is really conical, since the pupil of the eye is smaller than the segment of flame E L, but as the horizon is very distant the sides are approximately parallel. All the light from below this segment, and a part of it, will be cast upon the sea. D G is reflected in the direction G R, and B K in the direction K T. Similarly all the light from above this segment, and a part of it, will be sent to the sky B G, reflected in the direction G S. Hence the segment of the flame, rays from which are sent to the horizon, should be taken as much from the upper and the posterior portion of the flame as is consistent with obtaining a good body of light.



3rd. The Lower Totally Reflecting Zones.

If the reflecting surface be flat, it will send to an

eye on the horizon rays from a segment analogous to that described in the case of the upper reflectors. All the rays from the parts of the flame that are lower, or

posterior to this segment, and a part of the rays from it, will be reflected to the sea; but as the lamp itself

cuts off a large proportion of these, the lower prisms cannot be very serviceable for illuminating the near



surface of the sea. Similarly, all the rays from those portions of the flame that are higher or anterior to the said segment, and a part of the rays from it, will be reflected to the sky. Hence this segment should

be taken as far forward in the flame as is compatible with obtaining a good body of light.

J. H. GLADSTONE.

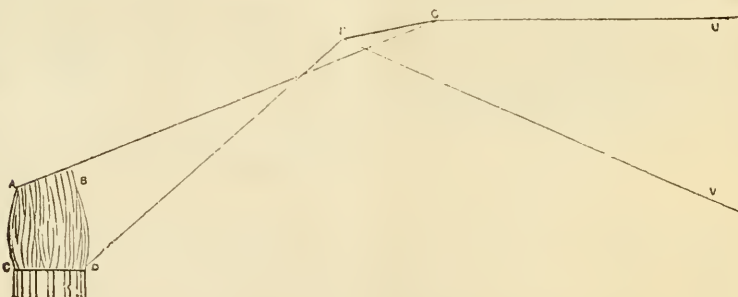
July, 1860.

4. Addition made on August.

If the reflecting surface of the prisms be flat it must cause a wide divergence of the rays; A G being

reflected in the direction of G U and D K in that of K V.

This divergence is lessened by making the reflect-



ing surface concave. The curve may be made of such a nature as to bring all the rays proceeding from a luminous point F in the directions M and N, to an eye on the horizon. In that case the ray A G, will be reflected in a direction G Y, and the ray D K, in that of K Z, giving a divergence much smaller than before, and causing the light that falls

on the sea to be sent nearer to the horizon. In fact, the curving of this surface produces a precisely analogous effect to the interposition of the lens in the course of the direct rays from the flame to the eye on the horizon; and all the remarks made on that subject and on the proper place for the focus F will, *mutatis mutandis*, apply here also.



LETTERS FROM THE ASTRONOMER ROYAL.

Royal Observatory, Greenwich,
London, S. E., 2d April 1860.

MY DEAR SIR, To place before you different points as they occur to me, I will give the following results of calculation of dip (omitting refraction).

Taking 4,000 miles for the earth's radius, a light-house, to be visible on the horizon at 30 miles distance, must be elevated 594 feet. Using this as basis of calculation, the following are the dips for a ship at different distances :—

Miles.	°	'	"
30	-	-	0 25 47
25	-	-	0 26 13
20	-	-	0 27 56
15	-	-	0 32 14
10	-	-	0 42 58
5	-	-	1 19 30
4	-	-	1 38 25
3	-	-	2 10 14
2	-	-	3 14 21
1	-	-	6 28 0
$\frac{1}{2}$	-	-	13 0 0
$\frac{1}{4}$	-	-	26 45 0

Now, in reference to the wants of nautical men, ought we to be sure to provide for light at the small distances as well as at the great ones? The subject may be important if we contemplate the use of very small sources of light, as the galvanic spark.

I am, &c.

Admiral W. A. B. Hamilton, G. B. AIRY.
&c. &c.

Royal Observatory Greenwich,
7th April 1860.

MY DEAR SIR, I RETURNED from Birmingham on Tuesday evening.

I went to Birmingham a little earlier than I had intended, in order to try the Australian fixed light at night. It is a light for an island, and shows light at seven faces of eight. I did not give much attention to the reflector, but observed carefully the adjustments, &c. of the prisms. The following is the general report on them.

The individual prisms were all properly curved and all well adjusted. I cannot say that one was better than another. (I have forgotten to say that four posts had been erected at my request, the distance of the furthest being 450 feet; and bench-marks at the same level had been established on them by spirit-levelling; and by means of these certain marks had been made at the height of definite parts of the glass frame, and by these my observations were made). Each panel of prisms that I examined appeared excellent. The vertical spread of light in each prism seemed considerable, fully 1° with undiminished intensity; but this I found solely to be attributable to the vertical depth of the great lamp (for the dioptric part), and to the depth and breadth (for the upper catadioptric part). Then I had various parts covered, so that I could examine separately,—the central dioptric part, and the upper and lower catadioptric parts. I saw immediately that the dioptric part threw its light too high, and that the catadioptric parts threw their lights too low. The error in each case was considerably under 1° ; but yet, though (as I have said) the spread from every individual beam exceeded 1° , besides giving a quantity of stray light, produced, I suppose, by petty flaws, and illuminated particles in the glass, yet this error in the general direction of the masses of light immediately attracted attention. The inference was, that the lamp was too low. We raised the lamp pillars $\frac{1}{2}$ of an inch, and all was then right. During this time the lamp-flame had been, as I understand, at the full English height, not at the full French height. When the lamp-flame was lowered, the faults exhibited themselves again. The height of the lamp-stand had been adjusted by the engineer's usual rule.

No light-frame, I believe, had ever been examined so well before.

I consider this examination important, as showing the following points :—

1. The general excellence of the system of grinding the prisms, and arranging them in each frame, by the operations in Messrs. Chance's long gallery.
2. The necessity for another examination when all the frames are united.
3. The importance of not being bound by such a rule as had been adopted by the engineer.

The engineer had provided, for the lightman's guidance as to height, an apparatus of strings running through very small holes, too delicate (I thought) for coarse hands. I suggested a little pillar standing on the pedestal.

My observations show the importance of attending more carefully to height of lamp than has yet been done, and show that in the use of small sources (as the galvanic spark) it will be *extremely* important to be assured that the height is always the same. I have written to Faraday to ask him whether he is certain of this constancy of height.

After this I examined carefully (in the day) the mathematical process on which is founded the experimental process by which the curvature of the curved reflecting side is examined. It appears quite correct.

Subsequently I saw the testing of one of the external rings of a lens in the long gallery. This was going on as a matter of daily manufacture, and was not put up for my edification. It was excellent. I had no idea that a ring could be ground to do its duty with so much accuracy.

General Inference.

At present, the great excellence of a lighthouse is or may be the optician's part. The great defect and waste is in the source of light.

I am, &c.,

Admiral W. A. B. Hamilton, G. B. AIRY.
&c. &c. &c.

Royal Observatory, Greenwich,

MY DEAR SIR, 11th April, 1860.

ON the other leaf I place excerpt of a letter which I have received from Faraday, regarding the vertical adjustment of galvanic lights. He has no fear about it, but remarks on the care which it may require.

I mentioned to you my strong objection to the entertaining of any proposal for use of glass prisms and lenses, shaped by any process except grinding. The inconsiderate parsimony which has induced anybody to contemplate the use of pressed glass for light-houses is to me totally incomprehensible. Let any one examine the straggling beams of light that are given by the sun shining through an ordinary window glass, or let him view a complicated prospect, as seen through such a glass, and then compare them with the same things as seen through a good ground plate glass, and he will see what would be lost by such adoption, or rather, he would see *part* of what would be lost. For, I believe, that the accuracy of form which can be given to a pressed piece of cast glass is far below the accuracy of parallelism of the two surfaces of blown or sheet glass in ordinary windows; and its error on the direction of a beam of light greater than that of a window glass, in the same degree; and this in a case where the smallest error is ruinous. An error of 1° in the transmission of light by a window glass produces no danger, and does not make the window useless; but an error of 1° in the lighthouse beam would make the lighthouse inefficient, and would produce great dangers on the coast. And I believe that the materials proposed for use would be liable to produce even a greater angular error.

The per-centage of saving, which the adoption of this imperfect substitute for ground glass would produce, would be very small. The Skerry Vore Light-house cost about 80,000*l.*; others have cost from 10,000*l.* to 40,000*l.* Imagine this expense in fact thrown away to save 200*l.* or 300*l.* in the glasses. It is in fact a kind of economy which no one who uses spectacles would adopt in his spectacle glasses, and which no hospitable entertainer at dinner would adopt in his dinner service.

Admiral W. A. B. Hamilton,
&c. &c.

I am, &c.
G. B. AIRY.

EXTRACT from a Letter from Professor FARADAY to the ASTRONOMER ROYAL, dated 9th April 1860.

"As to your inquiries about the electric spark, the lamp that Prof. Holmes has had constructed *practically* works well; for, being adjusted, an edge or object near the light throws a shadow on a distant wall whose place does *not* vary. The keeper watches this shadow from time to time (or such a shadow), and if there be a change, corrects for it, but the compensation for a change of place in the carbons, either upper or lower, has been very good. I have no fear for the place of the magnetic electric spark, provided we can secure the attention of the keepers; that will not be called for more than is required by the *written regulations now*, or than was given by the keeper at the South Foreland; but it must be a good deal more than what is absolutely *necessary for an oil lamp*.

"If the electric light should come into use, it seems to me that there will be no difficulty in bringing both the vertical and the horizontal divergence easily under command."

Royal Observatory, Greenwich,
London, S.E.

MY DEAR SIR, 14th April, 1860.

With this I return Mr. Campbell's excellent letter. The process which he has used at the Point of Ayre is *exactly* what I had intended to use at the South Foreland or the Start: with this modification only, that I had intended to provide myself with two pieces of dark cotton, so that I could cover all above and all below a single prism or a single set of prisms, and could thus analyze the operation of every individual part of the optical apparatus. I think that in the extension of operations some such arrangement will be found useful.

I am, &c.
Admiral W. A. B. Hamilton, G. B. AIRY.
&c. &c.

Royal Observatory, Greenwich,
25th May 1860.

MY DEAR SIR, I THINK it desirable to put on record my impressions derived from the examination of the Start Lighthouse. I wish that I had done so sooner, but my time has been very closely occupied.

1. Fixed frame in which the rotating part revolves. The part of this frame which guides the axis of the rotating part is not quite vertical. The error which it produced on a 2 feet plumbline was about $\frac{1}{4}$ inch forwards or backwards, so that probably the top is in error about $\frac{1}{2}$ inch with respect to the bottom.

2. Corrections of radius of the rotating polygon. There is no error worth mention.

3. Eccentricity of lamp. The lamp is about $\frac{1}{2}$ inch eccentric. This arises, I suppose, from the want of verticality of its pillar support, which is disreputably conspicuous to the eye. The workmanship is not good.

These errors do not in themselves produce any sensibly injurious effect with the existing large lamp, supposing it fully lighted up. (With very small lights they would be intolerable.) But in combination with the fault of lighting the lamp of which I next speak, No. 1 may produce a sensible effect.

4. Elevation of lamp flame. On examining the

position of the inverted image of the W.S.W. sea and sky over the lamp, as formed by the central lenses of the sections of the rotating frame, it appeared that, (with irregularities to be mentioned) the image of the sea horizon is about 1.1 inch above the lamp rings, oftener more than less. When the lamp was lighted, as in the usual way, its outermost ring of flame was barely as high as this, or not so high. Consequently, the whole of that light is thrown into the sky, and is useless to ships. The two internal rings of flame probably send their brightest light to the sea horizon, or nearly so, and, upon the whole, their arrangement is not injudicious. Yet, considering the effect of the external ring of flame, a greater quantity of light might be sent to the horizon, and a much greater quantity on the sea generally (including the near distance) if the lamp were raised $\frac{1}{4}$ inch.

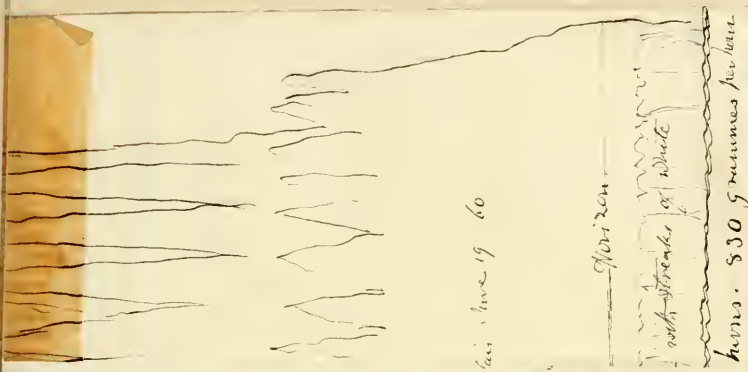
5. Loss of light on the unarm'd sides of the light-house. On $\frac{2}{3}$ of the circumference, if my recollection is correct (possibly less), no light is shown, and the light radiating from the lamp in that direction is in no way utilized. In the circumstances of a revolving light (as the Start), the only method of utilizing this light appears to be, to plant a spherical concave mirror, whose centre is the lamp, *in the inside* of the rotating part, but *not carried by* the rotating part. When (as in the Start light) the floor does not rotate, this can be done without difficulty. In some constructions I think there might be difficulty.

6. Form of the central lenses. The greater proportion (about six) of the central lenses appeared to me to be not badly shaped; the image of the sea horizon occupied pretty nearly the same place as viewed by light coming through the centre, the top, the bottom, or the sides of the lens. The foci of some fell short of the lamp centre, or beyond it; but with the large lamp this is unimportant. But there was one lens extremely bad; it produced a distortion like that of a knob of crown glass. It could never have been verified, and must be regarded as very discreditable to the maker. (This is a very advantageous specimen of what would be produced by pressed glass.) There was another, bad in a minor degree.

7. Form of the ring lenses. The curvature of the surface of the rings is exceedingly erroneous. The image of the sea horizon produced by each ring, instead of being something like a horizontal line, as it ought, is in all cases a line clinging to the circular form of the ring, so that the inner portion of the ring is usually seen bright and the outer portion dark (or vice versa). I suspect that the rings have been ground in a spherical bowl, which would give equal curvatures in radial and tangential directions, and this would be erroneous. Mr. Chance's process, of causing the ring to rotate round the optical axis, while the transverse curvature is determined by the nature of the cross stroke of the polisher, controls perfectly the relation of the curvatures, and gives the power of impressing the proper form on both. From what I saw, of a lens ring under test, and of the general processes of testing at Messrs. Chance's works, I scarcely doubt that their curvatures are quite correct. I should much like to examine them on a sea horizon.

8. Upper fixed reflectors. There are 7×19 fixed looking glass reflectors, each adjustable by its separate screws. These screws do not strain the form of the glass, but only alter its general position. The mirrors are therefore subject to two examinations, one for form, the other for position. The examination for form is difficult (on account of the elevation) and tedious (on account of the number); and where these circumstances hold, many faulty mirrors will infallibly be inserted. Some of them gave the image nearly as it ought to be seen, but I was not provided with proper apparatus for the examination. Some *certainly* gave the image as it ought not to be seen, and some were *worthless*.

For examination of position, there is provided a small apparatus based on the principle of observing the surfaces of a coloured fluid in two rising ends of a horizontal tube. It is a fault of principle in this,



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I omitted to observe when
at the South Light.

illumination to something more than a semi-circumference. The south light has reflectors in the blank part; the north light has none. They bear the name of Chance, in an inscription in large letters on the supporting pillar, from which, as well as from the statements of the lighthouse keepers. I infer that the entire light-frame was made by Chance's firm. The external lantern was made by Wilkins. The lights are at the same height, 240 feet above the sea.

3. The dioptric part of the apparatus is beautiful. The glass is of the best quality. The working is so perfectly true that in viewing the image of the

three fourths of the light is absolutely thrown away, and in the south lighthouse nine tenths of the light is absolutely thrown away. When, with a ruler, I covered the part of the flame which merely gave light to the sky, it was absurd to see how little was left for the useful part. The lighthouse keepers saw and understood it as well as myself; and my son can tell you as accurately as I can how large is the loss. It really gave me a feeling of melancholy to see the results of such exquisite workmanship entirely annihilated by subsequent faults in the mounting and adjustment.

The per-centage of saving, which the adoption of this imperfect substitute for ground glass would produce, would be very small. The Skerry Vore Light-house cost about 80,000*l.*; others have cost from 10,000*l.* to 40,000*l.* Imagine this expense in fact thrown away to save 200*l.* or 300*l.* in the glasses. It is in fact a kind of economy which no one who uses spectacles would adopt in his spectacle glasses, and which no hospitable entertainer at dinner would adopt in his dinner service.

Admiral W. A. B. Hamilton,
&c. &c.

I am, &c.
G. B. AIRY.

EXTRACT
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Admiral

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There is no error worth mention.

3. Eccentricity of lamp. The lamp is about $\frac{1}{8}$ inch eccentric. This arises, I suppose, from the want of verticality of its pillar support, which is disreputably conspicuous to the eye. The workmanship is not good.

These errors do not in themselves produce any sensibly injurious effect with the existing large lamp, supposing it fully lighted up. (With very small lights they would be intolerable.) But in combination with the fault of lighting the lamp of which I next speak, No. 1 may produce a sensible effect.

4. Elevation of lamp flame. On examining the

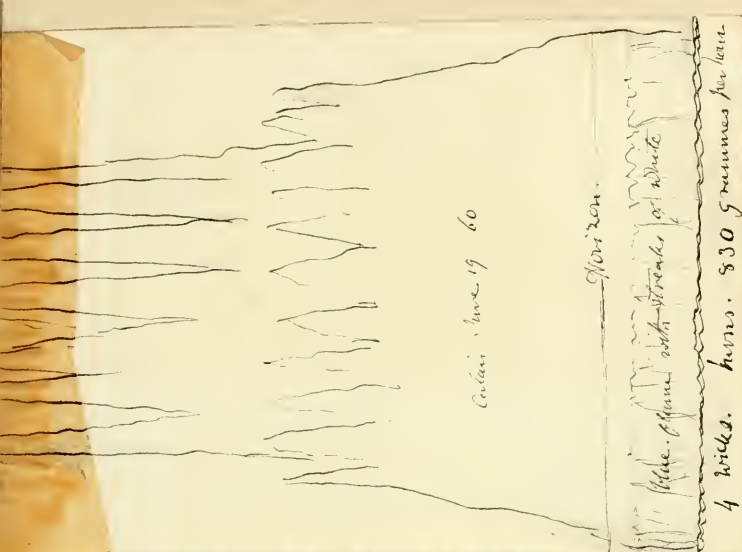
position of the inverted image of the W.S.W. sea and sky over the lamp, as formed by the central lenses of the sections of the rotating frame, it appeared that, (with irregularities to be mentioned) the image of the sea horizon is about 1.1 inch above the lamp rings, oftener more than less. When the lamp was lighted, as in the usual way, its outermost ring of flame was barely as high as this, or not so high. Consequently, the whole of that light is thrown into the sky, and is useless to ships. The two internal rings of flame probably send their brightest light to the sea horizon, or nearly so, and, upon the whole, their arrangement is not injudicious. Yet, considering the effect of the external ring of flame, a greater quantity of light

*Prisms slightly raised
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not even so numerous (on account of the number) and tedious (on account of the number); and where these circumstances hold, many faulty mirrors will infallibly be inserted. Some of them gave the image nearly as it ought to be seen, but I was not provided with proper apparatus for the examination. Some certainly gave the image as it ought not to be seen, and some were worthless.

For examination of position, there is provided a small apparatus based on the principle of observing the surfaces of a coloured fluid in two rising ends of a horizontal tube. It is a fault of principle in this,



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If, instead of the large lamp, there were a small ball of lime, or a galvanic spark, the optical failing would be intolerable.

I am, &c.

Admiral W. A. B. Hamilton, G. B. Arry.
&c. &c. &c.

Royal Observatory Greenwich,
16th June, 1860.

MY DEAR SIR,

1. I returned late last night from the Whitby expedition. I reached Whitby on the evening of 13th, and (after being provokingly misled about the locality of the lighthouses), found them, and took a partial view in the same evening till the time of lighting the lamps. On the morning of 14th I went to them in a carriage; and, as they are near the Scarborough road, I drove on to Scarborough, and thence made Hull on that evening. Yesterday, 15th, I returned by way of Lincoln. In order first to despatch unscientific business, I will mention that my son Hubert accompanied me, and was useful in the observations, as well as a comfort to myself (indeed I should have been unwilling to go alone), and I therefore think it right to consider him as a chargeable assistant.

2. The two lighthouses are on the edge of the high cliffs between two and three miles S.E. of Whitby. They are about 300 yards apart, and act as leading lights for warning of a rock called the "Whitby Rock;" both are first class fixed lights; and each gives illumination to something more than a semi-circumference. The south light has reflectors in the blank part; the north light has none. They bear the name of Chance, in an inscription in large letters on the supporting pillar, from which, as well as from the statements of the lighthouse keepers, I infer that the entire light-frame was made by Chance's firm. The external lantern was made by Wilkins. The lights are at the same height, 240 feet above the sea.

3. The dioptric part of the apparatus is beautiful. The glass is of the best quality. The working is so perfectly true that in viewing the image of the

please me. The general form, I believe, is pretty correct, but the details of the form are bad. The image of a straight bar as seen in them is as crooked as a sheet of corrugated iron. If I could have shut up the lighthouse into perfect darkness, and could have put a common candle in place of the lamp, I could have judged better of the effect of the reflected light. But my impression is that the reflectors are of very little use.

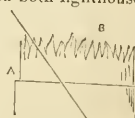
6. So much for the apparatus as prepared for use in the lighthouse. Now I proceed to speak of its adjustment in the lighthouse.

7. Upon comparing the height of the image of the sea horizon with that of the metallic part of the lamps, I found that in the north light the image of sea horizon was more than 1.1 inch above the metal, and in the south light more than 1.5 inch above the metal. The height of the lamp flame was stated by the attendants at about 2.5 inches; but when the lamps were lighted, and maintained to what they considered the usual and proper height, I found that a great part of that 2.5 inches was the spikes of the flame. On examining the image of the sea horizon, with the lamps lighted (which is by very far the best way), the following results were obtained:—

8. Dioptric part. In the N. lighthouse, a very insignificant part of the continuous flame (with its spikes) rises above the image of the sea horizon. In the S. lighthouse, the spikes only of the flame rise above the image of the sea horizon. In other words, scarcely any part of the light falls upon the sea, distant or near; the great mass of light is thrown to the sky.

9. Lower catadioptric part. In both lighthouses an insignificant part only of the light falls on the sea; in fact, we pronounced the lower parts to be useless.

10. Upper catadioptric part. In both lighthouses the useful part of the light would be nearly defined by a sloping line as drawn in this diagram. The part A of the flame is useful, the part B is useless.



11. My impression is, that in the north lighthouse three fourths of the light is absolutely thrown away, and in the south lighthouse nine tenths of the light is absolutely thrown away. When, with a ruler, I covered the part of the flame which merely gave light to the sky, it was absurd to see how little was left for the useful part. The lighthouse keepers saw and understood it as well as myself; and my son can tell you as accurately as I can how large is the loss. It really gave me a feeling of melancholy to see the results of such exquisite workmanship entirely *annihilated* by subsequent faults in the mounting and adjustment.

The per-centage of savir
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Admiral W. A. B. Hamilt
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EXTRACT from a Letter fr
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the lamp is situated (on account of the elevation) and
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and some were worthless.

For examination of position, there is provided a
small apparatus based on the principle of observing
the surfaces of a coloured fluid in two rising ends of a
horizontal tube. It is a fault of principle in this,

that it adapts the reflectors to give a steadily horizontal beam; but I see no difficulty in adapting it, by a small change, to give a beam dipping to a small angle below the horizon; and, with this modification, the advantage of the principle; but the details of construction and operation of examination are hard to see. The tube which carries the glass tube out of the hole in the floor, preserving the radial position, is not revolvable, yet there is no revolving rail to support the glass tube in its position. The vertical axis of the glass tube is in definite azimuths, and the glass tube is in a position to be placed ~~any~~ at any angle, and at any height, and at any distance from the hole in the floor, for the purpose of examining the hole. I have seen nothing like this in any of the things I have seen. It is impossible to see the cause of this. The way is understood. I suppose it is understood.

9. Practically, the faults, I must always be tormented by, are of a *vertical* character. A fault is to be estimated by its proportion to other faults to which it is added. Now there is the primary fault of the size of the lamp flame, producing a divergence in every beam of about 5° . If the aggregate of all other faults can amount to 5° , then, if the beam of light ought to be definite in the vertical direction only, its fault is doubled; if it ought to be definite in both dimensions, its fault is quadrupled (and at any rate its intensity is diminished to $\frac{1}{4}$). Now the refraction of the ring lenses is so bad that I think it likely that they do add 5° of divergence, and not improbably the reflectors do so. On the whole, I think it likely that the lighthouse does *not* give *half* the intensity of light which, as a large lamp lighthouse, it ought to give, independently of failing from want of dip of the beam of light.

If, instead of the large lamp, there were a small ball of lime, or a galvanic spark, the optical failing would be intolerable.

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Admiral W. A. B. Hamilton, G. B. Army.
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Royal Observatory Greenwich,
16th June, 1860.

MY DEAR SIR,

1. I returned late last night from the Whitby expedition. I reached Whitby on the evening of 13th, and (after being provokingly misled about the locality of the lighthouses), found them, and took a partial view in the same evening till the time of lighting the lamps. On the morning of 14th I went to them in a carriage; and, as they are near the Scarborough road, I drove on to Scarborough, and thence made Hull on that evening. Yesterday, 15th, I returned by way of Lincoln. In order first to despatch unscientific business, I will mention that my son Hubert accompanied me, and was useful in the observations, as well as a comfort to myself (indeed I should have been unwilling to go alone), and I therefore think it right to consider him as a chargeable assistant.

2. The two lighthouses are on the edge of the high cliffs between two and three miles S.E. of Whitby. They are about 300 yards apart, and act as leading lights for warning of a rock called the "Whitby Rock"; both are first class fixed lights; and each gives illumination to something more than a semi-circumference. The south light has reflectors in the blank part; the north light has none. They bear the name of Chance, in an inscription in large letters on the supporting pillar, from which, as well as from the statements of the lighthouse keepers, I infer that the entire light-frame was made by Chance's firm. The external lantern was made by Wilkins. The lights are at the same height, 240 feet above the sea.

3. The dioptric part of the apparatus is beautiful. The glass is of the best quality. The working is so perfectly true that in viewing the image of the

horizon, and moving so that it (the image) is shifted from the left hand band successively to the narrower left-hand jump or instead to the right hand forming its image in the same place. (If the same lenses, as I have reason to believe from the surface of the ring which I saw under trial works, there would not be the smallest step clinging of the horizon and the succession of tooth-like at the Start.) It is a work; possible only where and also a practical man-

4. The catches are partly very good, but not so strikingly good as the dioptric. The veins of the cornea, which I could not see any in the dioptric, were seen distinctly in catching the image with the dioptric. Still, there it was ; and in seeing that the boundary of the cornea for the whole as it ought to be, was very clear, as seen by direct

the south lighthouse did not please me. Their *general* form, I believe, is pretty correct, but the *details* of the form are bad. The image of a straight bar as seen in them is as crooked as a sheet of corrugated iron. If I could have shut up the lighthouse into perfect darkness, and could have put a common candle in place of the lamp, I could have judged better of the effect of the reflected light. But my impression is that the reflectors are of very little use.

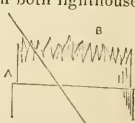
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7. Upon comparing the height of the image of the sea horizon with that of the metallic part of the lamps, I found that in the north light the image of sea horizon was more than 1·1 inch above the metal, and in the south light more than 1·5 inch above the metal. The height of the lamp flame was stated by the attendants at about 2·5 inches; but when the lamps were lighted, and maintained to what they considered the usual and proper height, I found that a great part of that 2·5 inches was the spikes of the flame. On examining the image of the sea horizon, with the lamps lighted (which is by very far the best way), the following results were obtained:—

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EXTRACT from a Letter to
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These errors do not in themselves produce any sensibly injurious effect with the existing large lamp, supposing it fully lighted up. (With very small lights they would be intolerable.) But in combination with the fault of lighting the lamp of which I next speak, No. 1 may produce a sensible effect.

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For examination of position, there is provided a small apparatus based on the principle of observing the surfaces of a coloured fluid in two rising ends of a horizontal tube. It is a fault of principle in this,

that it adapts the reflectors to give a strictly horizontal beam; but I see no difficulty in adapting it, by a small float, to give a beam dipping to or below the sea horizon; and, with this modification, I approve of the principle; but the details of carrying out the operation of examination are barbarous. The stand which carries the glass tube ought to revolve in a circle, preserving the radial position of the glass tube; yet there is no revolving radius to carry the stand in this position. The vertical ranges of mirrors are in definite azimuths, and the stand ought in succession to be placed opposite these; there are no marks for the purpose. The horizontal tiers are at definite heights, and the glass tube ought in succession to be placed at those heights; there are no marks for the purpose. In all the adjustable machinery that I have seen, I never saw anything so bad. It is *impossible* that the adjustments can be often examined.

The whole of this system is unsatisfactory, but I suppose it will never be repeated.

I omitted to mention that some of the looking glasses are much tarnished.

9. Practical effect of these faults. It must always be borne in mind that the effect of a fault is to be estimated by its proportion to other faults to which it is added. Now there is the primary fault of the size of the lamp flame, producing a divergence in every beam of about 5° . If the aggregate of all other faults can amount to 5° , then, if the beam of light ought to be definite in the vertical direction only, its fault is doubled; if it ought to be definite in both dimensions, its fault is quadrupled (and at any rate its intensity is diminished to $\frac{1}{4}$). Now the refraction of the ring lenses is so bad that I think it likely that they do add 5° of divergence, and not improbably the reflectors do so. On the whole, I think it likely that the lighthouse does *not* give *half* the intensity of light which, as a large lamp lighthouse, it ought to give, independently of failing from want of dip of the beam of light.

If, instead of the large lamp, there were a small ball of lime, or a galvanic spark, the optical failing would be intolerable.

I am, &c.

Admiral W. A. B. Hamilton, G. B. ARMY.
&c. &c. &c.

Royal Observatory Greenwich,
16th June, 1860.

MY DEAR SIR,

1. I returned late last night from the Whitty expedition. I reached Whitty on the evening of 13th, and (after being provokingly misled about the locality of the lighthouses), found them, and took a partial view in the same evening till the time of lighting the lamps. On the morning of 14th I went to them in a carriage; and, as they are near the Scarborough road, I drove on to Scarborough, and thence made Hull on that evening. Yesterday, 15th, I returned by way of Lincoln. In order first to despatch unscientific business, I will mention that my son Hubert accompanied me, and was useful in the observations, as well as a comfort to myself (indeed I should have been unwilling to go alone), and I therefore think it right to consider him as a chargeable assistant.

2. The two lighthouses are on the edge of the high cliffs between two and three miles S.E. of Whitty. They are about 300 yards apart, and act as leading lights for warning of a rock called the "Whitty Rock;" both are first class fixed lights; and each gives illumination to something more than a semi-circumference. The south light has reflectors in the blank part; the north light has none. They bear the name of Chance, in an inscription in large letters on the supporting pillar, from which, as well as from the statements of the lighthouse keepers, I infer that the entire light-frame was made by Chance's firm. The external lantern was made by Wilkins. The lights are at the same height, 240 feet above the sea.

3. The dioptric part of the apparatus is beautiful. The glass is of the best quality. The working is so perfectly true that in viewing the image of the

horizon, and moving the eye so that it (the image) is shifted from the broad central band successively to the narrower lateral bands, there is no perceptible jump or indistinctness, every band forming its image truly and exactly in the same place. (If the same accuracy be preserved in ring lenses, as I have reason to believe from the performance of the ring which I saw under trial at Chance's works, there would not be the *smallest* degree of the clinging of the horizon to the outline of the rings, and the succession of tooth-forms, which were so offensive at the Start.) It is a most beautiful piece of work; possible only where the maker is a man of science and also a practical man.

4. The catadioptric parts are very good, but not so strikingly good as the dioptric. The veins of the glass are seen (I could not see any in the dioptric), and there was some difficulty in catching the image of the line of horizon so sharply. Still, there it was; and there was no difficulty in seeing that the boundary of light did move over the whole as it ought. (The horizon was not very clear, as seen by direct view.)

5. The reflectors in the south lighthouse did not please me. Their *general* form, I believe, is pretty correct, but the *details* of the form are bad. The image of a straight bar as seen in them is as crooked as a sheet of corrugated iron. If I could have shut up the lighthouse into perfect darkness, and could have put a common candle in place of the lamp, I could have judged better of the effect of the reflected light. But my impression is that the reflectors are of very little use.

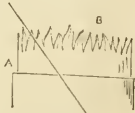
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7. Upon comparing the height of the image of the sea horizon with that of the metallic part of the lamps, I found that in the north light the image of sea horizon was more than 1.1 inch above the metal, and in the south light more than 1.5 inch above the metal. The height of the lamp flame was stated by the attendants at about 2.5 inches; but when the lamps were lighted, and maintained to what they considered the usual and proper height, I found that a great part of that 2.5 inches was the spikes of the flame. On examining the image of the sea horizon, with the lamps lighted (which is by very far the best way), the following results were obtained:—

8. Dioptric part. In the N. lighthouse, a very insignificant part of the continuous flame (with its spikes) rises above the image of the sea horizon. In the S. lighthouse, the spikes only of the flame rise above the image of the sea horizon. In other words, scarcely any part of the light falls upon the sea, distant or near; the great mass of light is thrown to the sky.

9. Lower catadioptric part. In both lighthouses an insignificant part only of the light falls on the sea; in fact, we pronounced the lower parts to be useless.

10. Upper catadioptric part. In both lighthouses the useful part of the light would be nearly defined by a sloping line as drawn in this diagram. The part A of the flame is useful, the part B is useless.



11. My impression is, that in the north lighthouse three fourths of the light is absolutely thrown away, and in the south lighthouse nine tenths of the light is absolutely thrown away. When, with a ruler, I covered the part of the flame which merely gave light to the sky, it was absurd to see how little was left for the useful part. The lighthouse keepers saw and understood it as well as myself; and my son can tell you as accurately as I can how large is the loss. It really gave me a feeling of melancholy to see the results of such exquisite workmanship entirely *annihilated* by subsequent faults in the mounting and adjustment.

12. If the lamp flames were burnt much higher, the proportion of loss would not be so great; but still the positive loss would be great.

13. To remedy the evils in this instance, and to make the lights truly efficient, the first step would be to raise the lamps about $\frac{3}{4}$ inch for the north lighthouse, and about $1\frac{1}{4}$ inch for the south lighthouse. This would make the dioptric part perfectly good; but the catadioptric parts would be made worse than they are at present. In order to correct them, the brass frames must be loosened, and their upper ends must be drawn outwards to an extent easily determined by trial. Then the whole lighthouse would throw a magnificent blaze on the sea.

14. I may point out two collateral proofs of the extent to which the defects of the lights have been practically experienced. The first is the introduction of reflectors into the south lighthouse and not into the north lighthouse; the explanation is, as I have stated, that the south lighthouse is in more faulty adjustment than the north. The second is, that sailors have made complaints that the lighthouse gallery cuts off the lower beams of light, and that it ought to be lowered; the explanation is, that in the fault of adjustment, all the light is thrown too high and none is thrown low.

15. To prevent the frequency or repetition of such faults as are conspicuous in these lights, I see no course but the appointment of a competent optical engineer, who shall be responsible for the careful examination of the lights in their place and in action.

16. I have now to submit another remark to yourself and the Commission. With whom the blame of this fault of adjustment rests I do not know, but I can say with certainty that the merit of the most admirable workmanship of the glasses is Messrs. Chance's. The state of these lighthouses must substantially be published; they will necessarily be connected with Messrs. Chance's name, and a great blame may be unjustly thrown upon those manufacturers. It is in my opinion much to be desired that a statement of the condition of the lighthouses, fully embodying a recognition of the beauty of the workmanship as well as an account of the fault of adjustment, should be communicated first to Messrs. Chance. (For instance, parts of this report might be copied, beginning with article 3 and ending with 14, and also one which I am going to subjoin.) Some steps might follow, in the way either of correspondence, or of material action, or of both; which, while they would not cause a suppression of the statement which I have made, would permit it to be given in such a shape as would prevent the commission of any injustice, or the excitement of any painful feeling.

17. The further statement which I had nearly omitted to make is this; that the engineer's work in the frame, &c., is of excellent quality, the lamp pillar is firm and truly central, and all the solid work appears to be of the highest order.

I am, &c.,

G. B. AIRY.

Admiral W. A. B. Hamilton,
&c. &c. &c.

Royal Observatory, Greenwich, S.E.

MY DEAR SIR, 25th June 1860.

I PROPOSE in this letter to lay before you the impressions which I have received from examination of the following five lighthouses, viz. :—

The High Light on the north bastion at Calais.

The Small Light of Cape de Valde.

The Light of Grisnez.

The South Foreland Light.

The North Foreland Light.

1. The High Light of Calais. The fundamental part of this light is essentially similar to to those of Whitby and the Forelands; a fixed light, furnished with bands of glass for the central or dioptric part, and with prismatic bands with internal total reflection for the upper and lower catadioptric parts. The

glass is good, but I think not equal to that at Whitby; and the relative adjustment of the contiguous bands perhaps not quite so good as at Whitby. In respect of adjustment of each panel of bands or prisms, this part of the structure may be considered an exact counterpart of the N. lighthouse at Whitby. The image of the horizon, as formed by the dioptric bands, is somewhat more than an inch above the lamp metal, and all parts of the lamp-flame above that height are effectual on the sea, by operation of the dioptric band. But from the lower prisms scarcely a ray reaches the sea, and from the upper prisms the light of a very small part only reaches the sea; they are practically useless.

In considering this instance, as also those of the two Foreland lights (both constructed by French artists employed by Messrs. Wilkins), and those of the Whitby lights (constructed under the immediate direction of a French gentleman, Messrs. Chance's foreman), I am inclined to think that a faulty rule has been, at some time, given by some practical authority in France, and has been slavishly followed in France and England.

Exterior to this fixed ring frame is a lightly constructed revolving frame, carrying (at equal distances on its circumference) three vertical panels, each composed of vertical bands nearly similar (*mutatis mutandis*) to the dioptric ring-bands. The intersection of these vertical bands with the horizontal bands or rings ought to produce exactly the effect of a lenticular panel. I was taken by surprise by this construction, and did not sufficiently examine the accuracy of the horizontal convergence of the rays. But having heard subsequently from the pilots at Dover that the lighthouse exhibits three flashes in the period of 4^m (the time of revolution of the frame), of which one is much brighter than the others; and having seen from Dover the extraordinary brilliancy of that flash; I am disposed to think that one of the flames is very well adjusted, and the other two very ill.

The central pillar bears the name "Francois jeune."

In the practice of adjusting the lamp there is a very great difference from those of Whitby. The rule is, to burn the flame to the height 0'10 metre, or more than 3'9 inches, and it was fully at that height when I saw it. With the dioptric part, probably the most brilliant light of the flame reaches the horizon, and nearly the whole of the sea is illuminated. This effect is very good, but might be considerably improved by proper adjustment of the reflecting prisms.

The lamp is fed by a pump. (For lamp glass, see Grisnez, below. For remarks on the reflectors in the blank sides, see Grisnez, below.)

2. The Small Light at Cape de Walde, or Valde. This is a fourth class light, and deserves no notice except as a specimen of a lighthouse with prisms, &c. made of cast unpolished glass. It is quite sufficient to condemn the system, even for such a little instrument as this. The quality of every surface is wretched; the form of every surface is faulty; the surfaces frequently have contrary or ogee curvatures. The proportion of light sent in any desired direction must be very small indeed.

3. The Light of Grisnez. This is similar to that of the Start (lenticular arrangement for the dioptric part, looking-glass reflectors for the catoptric part). There are the following differences of detail: instead of eight divisions, as at the Start, there are sixteen at Grisnez, and the number of reflectors at Grisnez is smaller than that at the Start. In the truth of the workmanship of the lens rings there is a prodigious difference. The rings at Grisnez are so truly curved that the line of the sea horizon is seen to traverse all, above or below the centre, without any clinging to the circumference, or any tooth-like interruption, as at the Start. Upon examining the adjustment of the dioptric panels, and of the looking-glass mirrors, it was evident that, supposing a good flame

on the lamp, every one of these would send light to the horizon and upon the sea, losing very little in the sky. The adjustment of this, now an old fashioned apparatus, is far the best that I have seen.

The keeper appeared to have no fixed rule of 0·1^m for the height of the flame. The height which he exhibited with his fingers was less than 0·1^m, perhaps 3 inches.

I omitted to examine the lamp feeder.

In the lamp-glass here, as well as at Calais, the form of the glass differs much from that in the English lamps. The contraction of the diameter, instead of being made by a square shoulder, as in the Whitby lamps, is made by a gradual slope of about $1\frac{1}{2}$ inch.

The diameter of the lamps is $3\frac{1}{2}$ inches, sensibly the same as that of the English lamps. The number of concentric wicks, four.

In this lighthouse, and in the Calais light, there are large reflectors on the blank sides. I believe that they are better shaped than those in the English lights, but they are so wretchedly dull (scarcely brighter than a pewter plate) that I do not conceive them to have any sensible utility.

4. The South Foreland Upper Light. This is a fixed light, precisely similar to those of Whitby and Calais. The glass is French (Lepaute), furnished by Messrs. Wilkins. The dioptric part is fairly good, but with more veins than in those of Whitby, Calais, or North Foreland; and the curvatures are not quite so well worked. In the catadioptric part, some of the prisms are abominably veiny, never through their whole length, but through about half, indicating some peculiarity in the manufacture of the glass. One or two of the lower prisms are sensibly out of adjustment, as compared with the others.

As regards the action of the lamp through the central dioptric part, the flame to the height of $1\frac{1}{2}$ inch throws its light to the sky. The lamp-flame is maintained to the height of $2\frac{1}{2}$ or $2\frac{3}{4}$ inches, and a great deal of its best part is effective on the sea.

As regards the catadioptric parts, the lower part is very nearly useless, and the upper part almost useless, as at Whitby and Calais.

There are reflectors for the blank sides, bright, but irregular in form, as at Whitby.

Lamp $3\frac{1}{2}$ inches diameter, with three wicks.

The lightkeeper said that there was great trouble in maintaining, with the fountain apparatus, a uniform high light, because when the oil was cold scarcely enough was supplied, and as soon as the lamp heated it ran over too copiously.

The reduction of the lamp-glass is not so square as at Whitby, and not so sloping as in the French lights. This is an effective light, but admits of being much improved.

5. The North Foreland Light. Exactly similar in form and arrangement to the Whitby, Calais, and South Foreland. The glass is beautiful (none but the Whitby glass comparable to it), the dioptric band well worked (not quite so well as at Whitby), the catadioptric prisms well adjusted together. The useless portion of flame for the dioptric part 0·9 or 1·0 inch high. Height of flame, as I understood, near three inches (the oil is supplied mechanically). The catadioptric parts are nearly useless, as in the Whitby lights. Bad reflectors on the blank sides, as at Whitby.

The lamp, as at Whitby and South Foreland, but there is a more careful apparatus for adjusting the height of the lamp-glass, which is praiseworthy. Lamp glass, as at South Foreland.

An effective light, but admitting of improvement.

Admiral W. A. B. Hamilton, G. B. AIRY.
&c. &c.

Royal Observatory, Greenwich,

MY DEAR SIR, London, S.E., 29th June 1860.

I enclose a letter which I have just received from Mr. Chance. It is clear, I think, that by

I.

judicious co-operation with him, we may do much to improve the lighthouses.

The note from Cookson's workman on the Start lenses is, at first, a little obscure, but I understand it perfectly. The rings and the central lens were all ground at once by a bowl-shaped grinder, as I suspected; a very different process from the cross-stroke grinding at Chance's. This rude note ought to be preserved, as a very interesting document for the history of the practical science.

My first recommendation to the powers would be —the Start Light must be entirely remodelled. It is a light of great importance.

Now, what in your judgment would be the best way for bringing together the Trinity Board, and Mr. Chance, and ourselves, for the improvement of the Whitby Lights? It may well be done before you make your report, and the amended state may make a good chapter at the close of the report.

I am, &c.

Admiral Hamilton,
&c. &c.

G. B. AIRY.

Royal Observatory, Greenwich,
London, S.E.

3rd July, 1860.

MY DEAR SIR,

I return the proof of Abstract of Evidence on Lighthouses, &c., as I must be clearing in reference to my journey to Spain.

I have no doubt that the failure of the Whitby High Lights to which you have directed my attention is *simply* in consequence of their optical badness.

I am, &c.

Admiral W. A. B. Hamilton, G. B. AIRY.
&c. &c.

Royal Observatory, Greenwich,

MY DEAR SIR, London, S.E., 4th July 1860.

I return the letters of Capt. Ryder and Mr. Campbell.

I like Mr. Campbell's proposal of shifting the individual reflective prisms, *but for the lower prisms only*. The diverging form of the upper prisms (which are more important) will not permit the change.

In regard to Capt. Ryder's proposed order of action, this is one of the matters of high politique in which I am not competent materially to interfere, only I say:—

1. The Whitby light is the most flagrant instance of mismanagement.

2. The constructor of every part of the Whitby apparatus is at hand.

3. The said constructor is willing to go heartily into the improvement of the Whitby light.

Therefore, leave all others and rest on it.

And I also say, as far as the Trinity Board is concerned, do everything openly and frankly towards them.

This in readiness for our possible meeting.

I am, &c.

Admiral W. A. B. Hamilton, G. B. AIRY.
&c. &c.

Royal Observatory, Greenwich,
London, S.E.

1st August, 1860.

MY DEAR SIR,

The point which I wished to have specially investigated in the High Calais Lighthouse, is this:—The frame is fundamentally that of a fixed light, distributing its light equally all round to a certain angular extent, or, at least, throwing the same constant light to Dover (for instance). And this constant light is varied by the rotation of a moveable frame, which embraces the fixed light apparatus, and which carries three sets of vertical glass prisms, with surfaces so curved as to produce (generally) the same effect of refraction in a horizontal plane, which the dioptric band produces in a vertical plane.

If these vertical glass prisms are properly adjusted, then, every time that any one of the three frames is

L

turned towards Dover, there will be a concentrated beam of light of great intensity thrown to Dover.

But it appears that, in point of fact, only one of the three beams, thrown in the course of a complete rotation, possesses any great intensity.

From this, I infer, that one of the three sets of prisms is well adjusted, and that the others are not.

The test would be this:—Select an object at a considerable distance, *not* a horizontal line like the sea horizon, but a *vertical* line like a lighthouse, or a point or small object like a ship. And when the prism frame under trial is turned towards such object, remark where the image of such object is formed,^o *not* in regard to up-and-down (as we have done for the ordinary tests by sea horizon), but in regard to *right-and-left*; and see whether its image, as viewed through the whole horizontal range of the prism frame, is in the same position (with regard to right and-left) for every one of the prisms, and for the whole breadth of each; and whether the said image is well formed by each; and whether all the said images are formed very near to the vertical axis of the lamp.

All the images ought to be well formed and united at the vertical axis of the lamp, and any fault in these respects would injure the action of the apparatus.

The prism frames ought not to throw the image of the sea horizon up or down; this also should be examined.

I am, &c.

Admiral W. A. B. Hamilton,
&c. &c.

G. B. AIRY.

Royal Observatory, Greenwich,
London, S.E.,

6th August 1860.

MY DEAR SIR,

THE points which struck me most in our late visit to the North Foreland Light, as additions to what I had previously recorded, are the following:—

1. The performance of the lamp was very bad; the flame, when steady, was much lower than when I saw it before. This circumstance, however, assisted by the depression of the lamp-flame (made, as I understood, within a few days), brought out far more clearly than could otherwise have been done the imperfection of illumination on the horizon and on the sea. When I saw the lighthouse before, there was good light on both from the dioptric part, the flame being then respectably high.

2. I suspected, from recollection of my former observation, and I now fully confirmed it, that the curvature of the reflecting surfaces of the upper and lower prisms, but especially of the latter, is much too sharp. In the instance which I measured best (2d lower prism), the horizon image, instead of being formed on the lamp, was formed 11 inches before reaching the centre of the lamp. The effect of this was to disperse the light up and down. In the present generally erroneous adjustment of these prisms, there may be advantage in this, because it throws some light on the sea; but if the prisms were generally well adjusted, much of the light, which would fall with great force on the sea, would be lost.

3. From a remark made by Mr. L. Sautter, it is plain that the peculiar effect of *reflection* is not fully understood by him. He said that the adjustment of the reflecting prisms was adapted to a high flame but not to a low flame. But in reality an addition to the height of the flame (though very valuable for the dioptric part) adds nothing to the useful effect of the reflecting part, as I have repeatedly stated; and Mr. Sautter's remark, therefore, must be without foundation, and expressed without clear understanding of the matter.

It occurs to me to suggest for Professor Faraday's consideration, whether, in a place so accessible, gas might not be used, either manufactured on the spot or led from Margate.

I intend to suggest to Mr. Chance some experiments for determining the special section of the lamp-flame which will send to the horizon the most brilliant light through the reflecting prisms.

I am, &c.

Admiral W. A. B. Hamilton,
&c. &c.

G. B. AIRY.

Royal Observatory, Greenwich,
London, S.E.

MY DEAR SIR,

9th August 1860.

I ENCLOSE a tracing of a sketch that I have made of the way in which I think the questions of adjustment of the reflecting prisms of lighthouses must be treated. I do not mean it as perfectly correct for angles, &c., but rather as a specimen of method.

I send a copy of it to Mr. Chance.

I am, &c.

G. B. AIRY.

You will remark that I still confine my practical ideas to oil lamps, or (which in form is the same thing) to gas lamps. I hope to see the galvanic light introduced, but it will require a very extensive change of lenses and reflecting prisms, and therefore will come very slowly. I am prepared with the principal considerations that will then have to be examined.

G. B. A.

Admiral W. A. B. Hamilton.
&c. &c.

Royal Observatory, Greenwich,
London, S.E.,

MY DEAR SIR,

8th September 1860.

I RETURNED yesterday morning, but had no leisure to write to you yesterday or this morning. This letter will be posted on the 10th.

I enclose M. Reynaud's letter, which would have been of the utmost importance to me if I had gone alone, and was probably extremely useful in the actual case.

My course of journey was this:—On Monday the 3d I went to Dover by 4:30 train, expecting Captain Ryder either by that train or by the next, and proposing to cross by the morning steambot; but the night became very fine and calm, and I determined to cross by the night boat. Established myself at Dessin's, and in the morning worked off the Calais Lighthouse. Finding that there is a diligence to Boulogne at 12, by which time the morning steamer would be in, I took two places on the diligence, and waited at a corner of a street for the steambot passengers. And there I picked up Captain Ryder. Then we went by the diligence (very slow) to Boulogne, and by railway to Abbeville, where we slept. On the morning of the 5th, at 10 o'clock, went by diligence to Dieppe, arriving at past 4. It was too late to do justice to Cap d'Ailly, so we arranged for starting at 6 o'clock the next morning, with the hope of quitting by the boat at 10:40 A.M. On the morning of the 6th started at 6 o'clock, reaching the lighthouse about 7:30, and proceeded to work, when a fog and shower came on which destroyed our horizon. We were compelled to wait so long that the steamer was effectually lost, so we transacted our business leisurely, repeating some of the examinations several times. Started by the steamer at 10:50 P.M.; was too ill to compare the Cap d'Ailly and Beachy Head Lights. Reached Newhaven on the morning of the 7th, and came to London and Greenwich.

1. In walking backwards and forwards on the Dover Pier, I remarked the way in which the South Foreland High Light comes into sight over the shoulder of the Downs. It appears as a very dull spark, very slowly increasing, till at last it rises rather suddenly into considerable brilliancy. I interpret it thus. The first view is of the upper prisms, which are so imperfectly lighted that even when all are in view their light is small, and therefore as they come gradually into view, the volume of light, small at the utmost, has increased slowly; at length the

[read on to page 85.

* See, however, the last paragraph.

Written explanation of the Decigram
which was shown & explained ^{verbally} to the party
in the train on the 2^d of August 1864

The Diagram is intended to illustrate the following properties.

That in right Houses the diverging beam
~~is~~ axis, or central plane is at
 right-angles to the perpendicular
 axis of the instrument, and has equal
 divergence above & below that plane
 in which its axis or central plane
 lies, is wrongly directed.

It should be directed downwards
its upper limit to a point a little above
the horizon, and its lower limit as near
to the light house as the divergence
will allow. —

It is to be granted that rays of light may be represented as if they followed the same course through the central point of a lens, which they would through a pin hole in a window shutter.

The pictures except those of the lamp, were all taken with the same camera, on glasses placed at the same distance from the lens, and from different elevations. They are consequently drawn to the same scale, which is represented as a scale of degrees, on a circle whose radius equals the focal length

of the lens used.

I wish to demonstrate.

That the higher a Dioptric apparatus (as now made), is placed above the sea level, the larger should be the number of degrees which the flame occupies on a circle whose radius equals the focal length of the apparatus.

in other words. -

The higher the lighthouse the larger the ^{flame} flame ought to be, in proportion to the focal length of the apparatus in which it is placed -

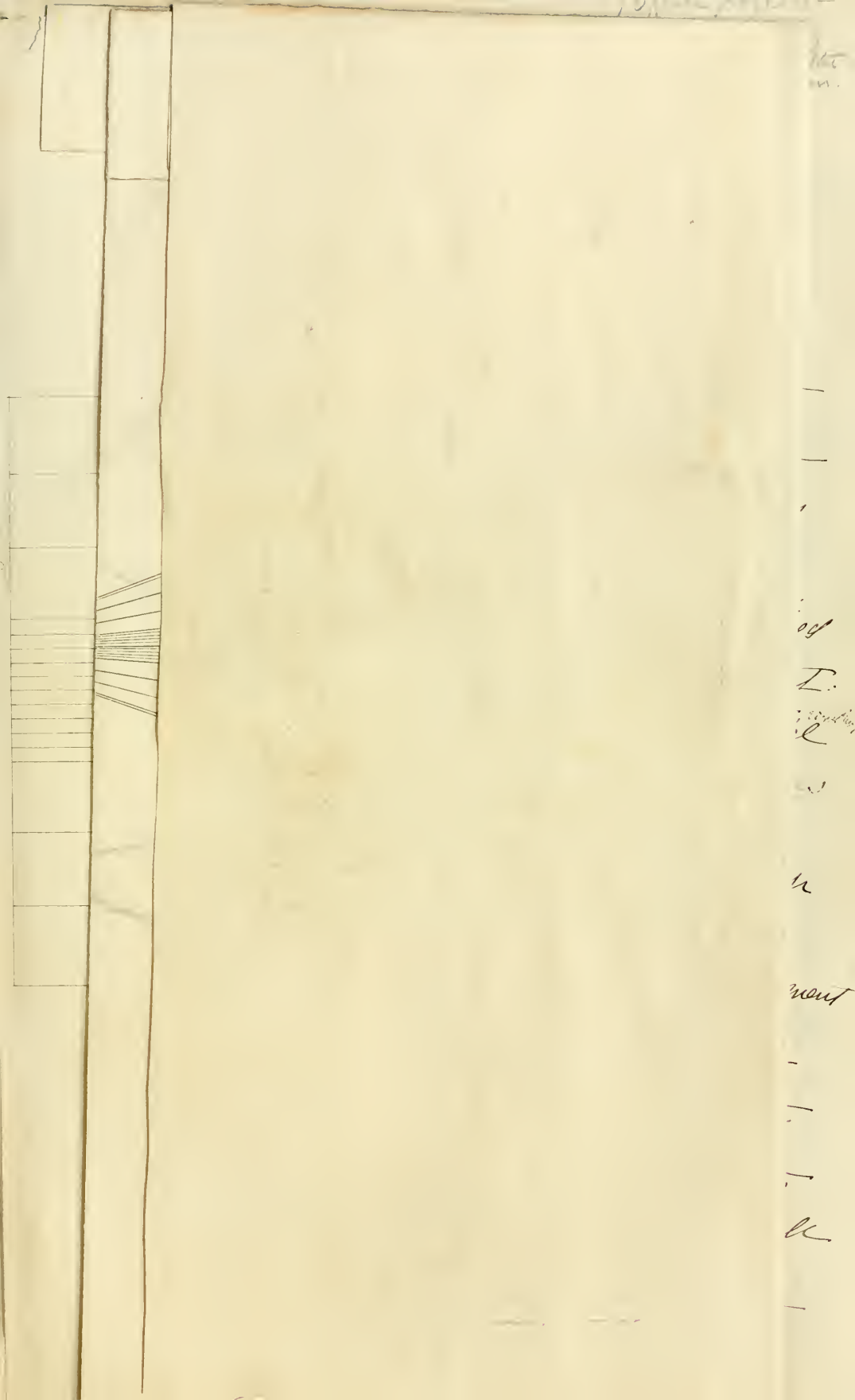
(Supposing that the light ought to be seen from points distant a certain number of miles from the Tower.)

~~The~~ Photographs are now ^{fixed} placed where I intend them to be placed and are intended to show nearly

what parts of the landscape represented would be illuminated by a flame of the size indicated; if placed instead of the glass screen, on which the pictures were actually taken.

The Photographs of the same also show the disadvantage of a shoulder in the chimney, and were taken for that purpose -

J. H. Campbell



of the ...

Rough copy.

Royal Commission,

Lights, Buoys, and Beacons,

7, Millbank Street, S.W.

London.

August 1/60

My dear Admiral

I wish to put in writing the
remembrance which I addressed to
you verbally ^{after the meeting on Monday 3.} ~~last~~, in the presence
of the whole Commission Mr. Greaves
excepted. I objected to the manner in
which my name was publicly mentioned
by the Astronomer Royal as unjust.
^{after you had stated why the Astronomer Royal had}
^{been asked to attend the Commission, & to remain in waiting}
~~He described what he had observed~~
himself, ^{but he also} ~~and~~ he mentioned two names
only mine and his sons
Of his son he spoke with praise which
I have no reason to think is bestowed
of me he spoke only with disparagement
He said that he himself and ^{Mr. Campbell the Secretary} ~~had~~ had
twice various methods of "observing the
mirage" "which we had been caused to
abandon" but he said nothing at all
of those experiments which I have

made sufficiently, and which have
been communicated to him by you

I do not admit that I have
abandoned the methods used by me
which are described in the Minute
book ^{or my letters to you} and to which on the contrary

I adhere. He said that he considered

the method last used by him, namely
that of looking through the flame & the
lens glass apparatus at the horizon
as the best. I believe it is. It was

tried (if I am not mistaken in his presence)
at the Stand ^{during} ~~on~~ ~~part of the Astronomer~~ on
first joint visit to a lighthouse &
~~to prove the~~ ^{theory} ~~was~~ to prove the correctness
of his card observations, and the lamp
was lighted on purpose.

^{on the other hand the astronomer Royal}
~~He~~ mentioned his son as having accompanied
him" which he did at his Father's request
and as having a considerable knowledge of
Optics which I am no doubt prepared, but
~~that~~ as Mr. Airey ^{junior} has done nothing
at all for the Commission ^{which} I have
worked hard ^{for a long time} as you are kind
enough to say with some success. It ~~seems~~
appears

unjust to ~~disparage~~ ^{in this matter} mention
my name, with that of Mr Airey junior
and to disparage me while praising
him. The effect of this public address
was such that I having subsequently
shown some knowledge of the subject
^{was asked by} a gentleman ^{inquest} ~~asked me if~~ "I were not
Mr Professor's son" having concluded
that some one else was the Secretary

Now you well know that I have
suggested to the Commission from
the ~~very~~ first the point which was
the subject of ^{discussion on the 30th} ~~the meeting yesterday~~

namely That air light houses, the
diverging ^{where axis is} beams ~~which is directed~~ at right angles

to the axis of the instrument, ^{it has} with an
equal divergence above & below the

plane at which it is plane ~~which~~
in which its axis lies. is wrong

^{you remember that I have pointed this out to you in English French & Spanish}
directed. ~~that it~~ ^{that} should be directed

downwards ~~so~~ ^{that} and the higher the
light house the greater the fault when
^{the beams} it is directed horizontally. - I also claim

to have pointed out long ago and
^{to the Commission} lately in a letter ^{shown to the Hydrographic Royal} to you the remedy

now adopted in principle, which is
wholly different from ~~that~~ ^{the remedy for} which was previously
suggested ~~at first~~ by the Astronomer Royal in
conversation; and by Mr. Chance, who worked
with him, in his replies to the Scientific
Questions, which are printed. ^{suggests} ~~scarcely~~
hoping the lenses -

Against this plan I have repeatedly
argued with what I feared to be
imbecile pertinacity, ^{where} even so late as on
our last French trip, when the Astronomer
Royal maintained at Calais that the ^{whole apparatus, in general,} ~~the~~ lenses
was the best cure for the defect,
which while I ventured to ^{insinuate} ~~hint~~ another
opinion. ~~and~~

The necessity of ~~hoping~~ ^{the} ~~the~~ causing
the beam to dip struck Mr. Faraday
more than 20 years ago. It is ^{referred} according
to his letter ^{on the 30th} ~~to~~ yesterday, but the point
has been neglected or misunderstood even
since, as appears from French & English
publications & from the actual observation
of the apparatus.

The ^{wrong} ~~mis~~ understanding of the point, is
as I conceive, the cause of the greatness
of the error in the Prismas at some of
the light houses, for in many, as at
the North & South Foreland, I find the

lamp correctly placed for the lens
and consequently too high for the
prisms. -

It seemed as I have already written
~~as if~~ ~~that~~ to you as if the lamp
had been revised to suit the lens
at ~~the~~ ^{its} elevation ~~in~~ ⁱⁿ the light house,
~~without reference to the prism~~ ^{lower prisms}
and this view was confirmed by ~~the~~
Professor Faraday's statement, ^{on the 30th} that
the electric light had been purposely
fixed above the focal plane. ✓

I do not claim to have discovered
anything new. But to have ^{been the first to} called
the attention of the Commission ^{very early} to
a point ^{which they took up} which has been overlooked
in practice; which several men of
science have overlooked in their
first answers to the scientific questions
and which is acknowledged to be an
important ^(important) point whenever it is
~~indicated~~ ^{is} explained the point which
^{is to be discussed tomorrow.}
I maintain that the Astronomer Royal
himself overlooked ~~it~~ ^{the point} at first, or considered
it unimportant. It was after the
visit ~~to~~ the Stant at the end of a long

held
disappear with me ~~as to the~~ in the
train concerning the instrument used
~~no student~~ to set the mirrors, that he for the
first time in my hearing admitted
that which I have maintained all
along. That these axis ^{of a & house} of beam
should be directed horizontally but to
a point between the sea horizon and
the light house. And in admitting that
he repeatedly said. I agree with you.

I appeal to my drawings not to
prove what I write out to enable
you to ~~follow~~ ^{as to} it, and I ask you &
the commission to see that I have
the credit which is my due of every
^{no matter how} ~~further argument~~ ^{or} ~~were of any nature~~
~~but that~~ a sense of justice ^{can be} ~~were~~ required
^{but} I would point out, that it is not wholly
unimportant for the Commission that
their Secretary should ^{in this matter} ~~have~~ ^{claim} his due ~~for~~
If he is totally eclipsed ~~his masters~~ ~~with~~
the shadow will obscure his masters.

Any one ignorant of ^{the} subject might have
concluded, ~~that~~ and probably most of those who
were present ^{on the 30th} ~~yesterday~~ did conclude, that the
whole of this originates with the Astronomer Reg.
^{as perhaps} his son, for there was not one word
in his public address to lead to the conclusion

Royal Commission,

Lights, Buoys, and Beacons,

7, Millbank Street, S.W.

London.

that the Commission or any one belonging
to it even had a single idea on
the subject before ^{the Speaker} they ~~appeared~~
was called in
Doyle appeared on the stage;
excepting always ^{those} certain abortive
ideas which ^{as Mr. Sturt} Mr Campbell the Secretary
had seen cause to abandon. —

Under these circumstances I wish
to make ^{this} formal remonstrance
against what I ^{consider} ~~look on as~~
~~injustice~~ and I write this letter
with the conviction ^{that you who}
~~in the hope that you will not~~
are acquainted with the ~~conduct~~ ^{conduct} of the State
~~will not think it unbecoming for~~
^{especially after}
our conversation this day. —

August 1. 1860

Copy of letter

to Chairman of

August House Committee

concerning meeting on

the 30th with the

Trinity School &

the Academy

Reverend.

to Stevenson that my belief was
 & every one I was ~~informed~~
 out to put me down -

The fact being that Professor

my sister on

my drawings ~~and~~

they were not

intended to be placed

when he was

shown into a corner &

only said that he was

very - said "I cannot hear."

the drawing shown to

Allen & Gladstone who admitted

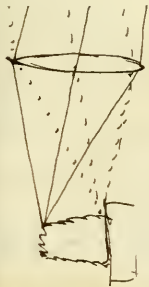
both were perfectly correct

with the most undoubted me

at - 12. Admiral & smaller

retinues. Aug 7. with a letter

My dear Mr. Gore
 I have received your
 letter of the 10th inst. &
 am glad to hear of
 the result.



Lead

But this was

to insert it

Among which is

standing at

where it is, to

the lines out

right angle, and equal
 other side ought in no
 best forwards. But not
 difficulty of construction
 not easily secured
 is, in

that the focal length
 of my lens is not
 quite correctly given.

Friday, Wedge
 Sensing this

August 3^d 1860

My dear Sir

I shall be exceedingly
 obliged to you if you
 will say whether the
 accompanying
 Diagram ~~for~~ ^{and}
 illustrates the ~~the~~ ^{the} ~~the~~
 explanation which
 is attached to it

~~and if that explanation~~
are correct in principle

I make this request
because it was difficult
either to speak or to
write distinctly in the
train yesterday, and
I may not have made
my meaning quite
clear to you

I fear that Mr
Stevenson and Mr

Chance have carried
away the impression
that you considered
the ~~statement~~ & my
explanation of it
erroneous. I
am anxious to have
the means of removing
such an impression.
I shall be exceedingly
obliged for your
answer --

I am
Yours most truly
JH

Royal Commission,

Lights, Buoys, and Beacons,

7, Millbank Street, E.W.

London.

August 7th 1860.

I send the diagram by carrier

Royal Observatory, Greenwich,
London, E.C.

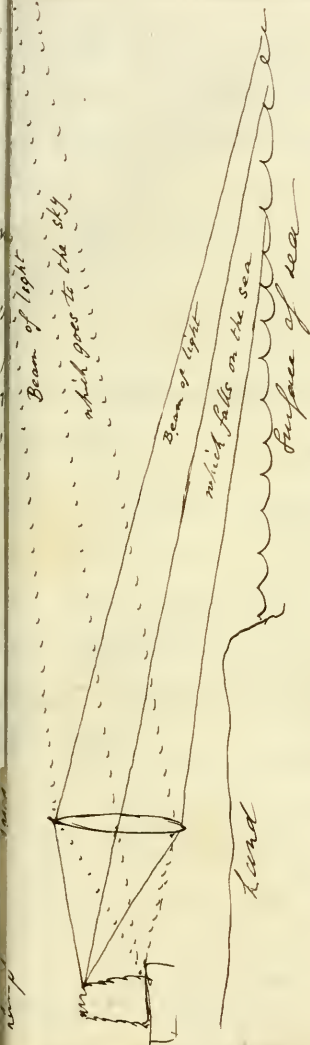
1860 August 7

My dear Sir

I did not at all dispute the geometrical correctness of your conclusion, but it seemed to me at the time that you had taken a diagram intended for a different purpose; the conversion of divergent lines into parallel lines, as it shewed upon the diagram, seemed to argue that the diagram was intended to represent a lighthouse with a lamp in the center, from which issued both ways diverging rays, which lenses converted into parallel rays.

J. F. Campbell Esq. *first of the explanation.*

that the focal length
of my lens is not
quite correctly given.



but this was left out because
to insert it would occasion a vast deal of
writing which is now omitted. And placing the diverging
lines by themselves, I have by this means
shown it is, to the only possible effect, that the
the lines would keep as to continue on to the reality.

~~and if that explanation~~
are correct in principle.
I make this request

And under this impression
it seemed to me that the matter
was much confused by putting
a lens in the middle.

But I gather from your present
explanation that I was wrong, and
that the lateral position of the
diagonal showing the parallel rays
were in reality scales transverse
to the beams of light: so that,
to make the thing more seriously
represent reality, the paper on
one side ought to be bent back.
-wards rather more than at
right angle, and that on the
other side ought to be equally
bent forwards. This, in the
difficulty of conceiving, was
not easily seized.

I want you both to
be sent the same thing
is all + then the boys would have the same

Chance home carried
away the impression
that you can succeed

There remains, as it seems
me, a little difficulty in this
that in putting the photograph of
country to where you do, you
depart too widely from the actual
nature of things. In reality
a pencil of light from any part
of the plane falls on the whole
breadth of the lens, and the paper
in its modified form, trans-
fers off to sea or sky at a very great
distance. Now though we can
put this very great distance on
into our sheet of paper, yet
we can, I think, do better to
put it at exactly the same distance
on one side of the lens as the
is at on the other side. I have
sketch on next page what I
have, my dear Sir,
Yours very truly

Royal Commission,

Lights, Buoys, and Beacons,

7, Millbank Street, E.W.

London.

August 7th 1860.

My dear Sir,

I am very much obliged
to you for your letter, and I hasten
to thank you for it. If I may
be allowed to use a slight figure
illustration it seems that the light
which your companion shed on my

As to the Diagram of the
Astronomer Royal. it is
right enough if its
dimensions are equal
to the fact but in no
other case. and I submit
that mine is strictly
accurate. except in
that the focal length
of my lens is not
quite correctly given.

is if that explanation
is correct in principle
make this request

under this impression
and to me that the matter
is confused by putting
in the middle.

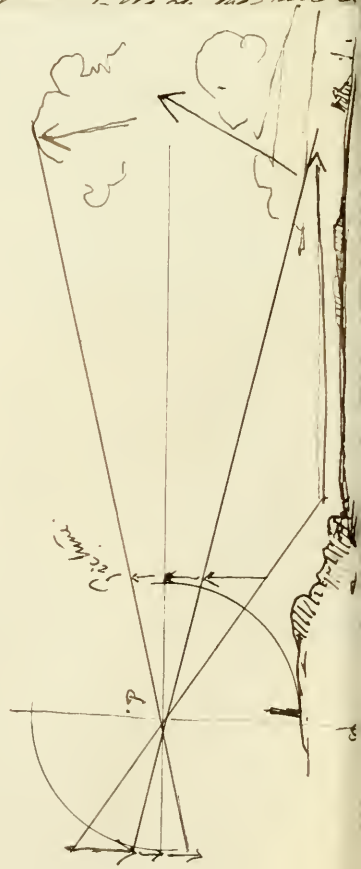
I gather from your present
letter that I was wrong, and
about nothing of the

Chance home. Curved
away the impression
that you can believe

There remains, as it seems
me, a little difficulty in this
that in putting the photograph of
country in where you do, you
depart too widely from the actual
nature of things. In reality
a point of light from any point
on the whole

If any lines other than straight lines
can be drawn from the image to the object
through P. so that they may correspond
with and pass through points in the picture which
correspond with to the reality. Then the
A.R. is right. If there is any other place but
that represents where the pictures can be
placed so as to fulfill these conditions then
I am wrong.

as my diagram is now placed. Lines could be drawn
from one picture through another to the points
represented through all the points which represent them



away

Royal Commission,

Lights, Buoys, and Beacons,

7, Millbank Street, E.W.

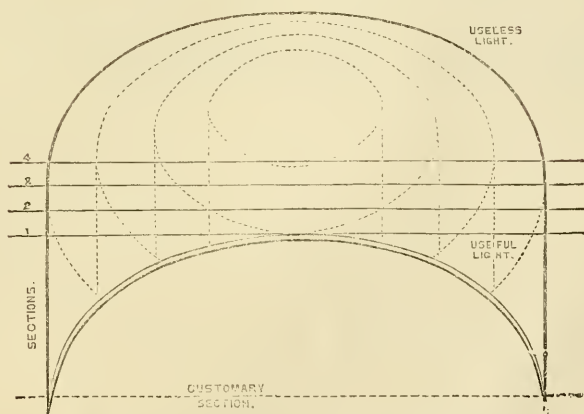
London.

August 7th 1860

My dear Sir,

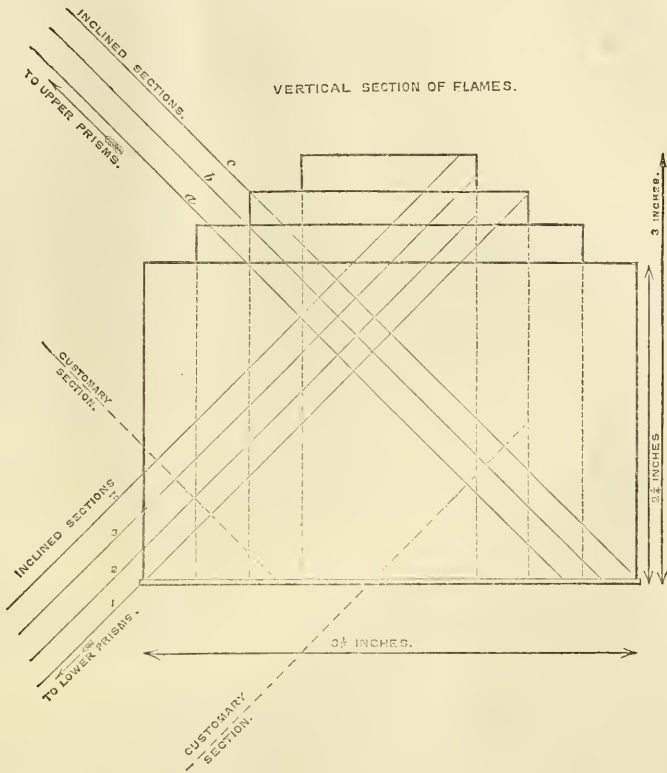
I am very much obliged
to you for your letter, and I hasten
to thank you for it. If I may
be allowed to use a light house
illustration it seems that the light
which your commission shed on my
"Diagram" was like a lighthouse reflecting
beacon only on those who heard and
did not understand the proposition
to me it seemed as clear as that

VIEW OF THE FLAMES FROM THE LOWER PRISMS.

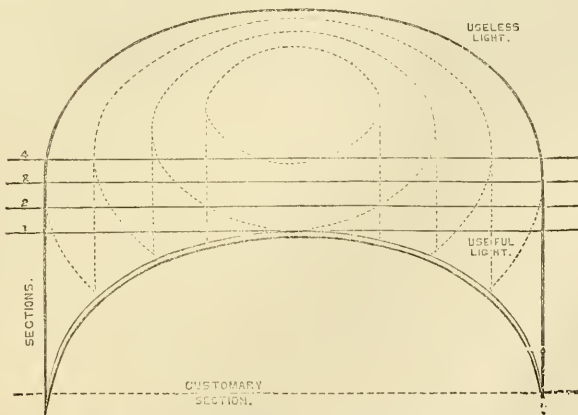


(With the Customary Section no light is really useful.)

EXAMINATION of the inclined sections of the Flames of a Lighthouse Lamp, for estimation of the most advantageous place at which the image of the sea horizon, formed by the reflecting prisms, ought to cut the flames. It is assumed that lines drawn from the centre of the lamp at an angle of 45° , upwards and downwards, will cut the centre and most efficient prisms.

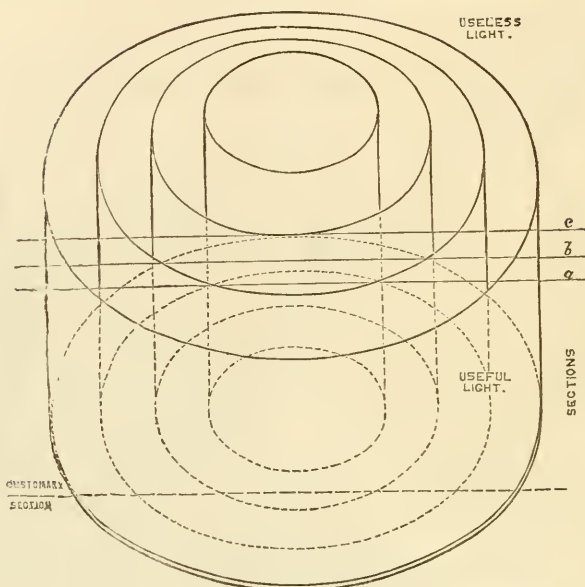


VIEW OF THE FLAMES FROM THE LOWER PRISMS.



(With the Customary Section no light is really useful.)

VIEW OF THE FLAMES FROM THE UPPER PRISMS.



(The only useful light for the Customary Section is the small part below its line.)

For the Lower Prisms:—

Section 1 appears at first sight to pass through the greatest quantity of light, and thus to send most light to the sea horizon; but in fact it does not, because it passes through a non luminous part of the outer flame, and it almost wholly destroys the light on the sea. It is inadmissible.

Section 2 is better.

I prefer Section 3, as combining all interests in the best degree.

Section 4 throws good light on the sea, but the light to the horizon is (in a very small degree) diminished.

For the Upper Prisms:—

Sections *a*, *b*, *c*, possess the different properties in degrees very slightly different.
On the whole I prefer Section *b*.

For Prisms above and below the assumed angle of 45° , it is nearly indifferent to what point they are adjusted, provided it is in the Section 3 or *b* (as the prisms are Lower or Upper) and within the limits of the lamp flame. If a point in the lamp axis be adopted, the rule will be this:—

Adjust the lower prisms to a point $2\frac{1}{4}$ high in the centre of flame.

Adjust the upper prisms to a point $1\frac{1}{2}$ high in the centre of flame.

9th August 1860.

G. B. AIRY.

central pannels give their light, which (from the circumstances of adjustment) is much more effective.

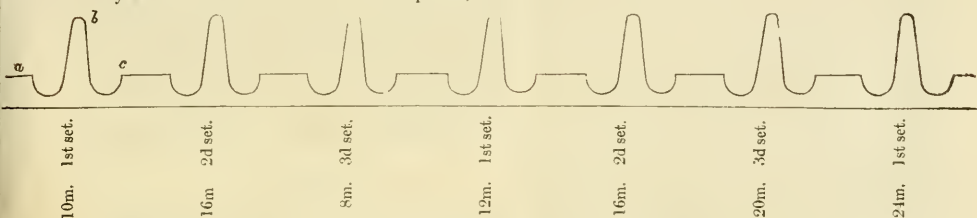
2. Shortly after leaving Dover Harbour, the South Foreland Lower Light comes into view. There was no mist whatever about the Downs, and both lights were seen perfectly well all the way to Calais. As the bearings of the lights slightly changed, their relative brilliancy slightly altered (evidently from window bars, position of reflector edges, &c.) The result of very careful examination was that the lights are exactly equal, sometimes one and sometimes the other being the brighter. Now the Lower Light is an old parabolic mirror light, and the Upper is a new first-class dioptric and catadioptric glass light. I conceive that this comparison is discreditable to the Upper Light.

3. The great Calais Light rose suddenly from the sea at about one third passage over, with good light and great brilliancy at its brilliant phase. Of the apparently triple phase I will speak hereafter. On the voyage I timed the brilliant phase and found the intervals to be 4 minutes.

4. I saw the light on the sands, which we had visited, (the sailors call it Cape Walldam). It really gives a more respectable light than I could have expected from such an unnatural contrivance.

5. In the Calais lighthouse, I examined very carefully the three moveable sets of vertical prisms, and

found all to be in excellent adjustment, a single prism in a single set being so far out of adjustment as to throw the image of a ship about $\frac{1}{4}$ -inch to one side, which is of no importance, and none of them disturbing the horizon. Their focus is nearly 1 inch in front of circumference of lamp, which does no hurt. (It would do hurt if the light were a galvanic spark.) I was a little puzzled about the apparent difference in the triple flash, till I had the clockwork attached, and the instrument moved "au naturel" as the man phrased it. I then tried the passages of the successive sets of prisms, and found the interval from set No. 1 to set No. 2 to be 4 minutes, and that from set No. 2 to set No. 3 to be 4 minutes, and the same No. 3 to No. 1; the whole time of revolution being 12 minutes. It was plain, therefore, that the apparent triplicity of phase, whose period is 4 minutes, does not belong to a difference of adjustment of the three sets of prisms, but is something peculiar to such prisms, and is the same for the three sets. And now I found the explanation. The vertical prisms absorb all the light of the central pannels a little before and a little after the brilliant flash (leaving only the light of the reflecting prisms), and collect that light for the flash. Thus the brilliancy of light is represented at successive times by successive vertical ordinates of the curve below:—



The pilot, who remarks that after *a* the light suddenly declines, sets down *a* as a flash; then comes the great flash, *b*, about which there can be no mistake; then the light suddenly rises to *c*, and the pilot considers this to be a flash. My first interpretation of all this was erroneous; and I am glad to have had the opportunity of correcting it; the correction is worth the journey.

6. I looked, but in a mere cursory way, at the general optical arrangements of the glass rings. I found those of the dioptric part very good (as before) for a large flame, the image of horizon being about 1'5 inch above the lamp-metals; and those of the reflectors as before to be defective, but not so defective as in the English lights.

7. In glancing at the machinery of rotation, in an engineering point of view, I found a fault which I could not have anticipated. Between the fixed plate and the revolving plate there is a chain of live rollers; and the diameter of each roller bears a large proportion to the diameter of the ring on which it runs. The slightest consideration would show that the fixed surface and the moveable surface, one or both, ought to be conical, their vertices meeting at a point; and the rollers ought to be conical, their vertices being at the same point. To my great astonishment I found that the plates are both flat; the rollers, consequently, are always scraping upon the plates, either with the inner edge of bearing, or with the outer edge. The keeper told me that the rollers at first were of iron, and so much of scales was torn up every night that it was necessary to sweep the plates every morning. Rollers of gun-metal are now substituted, and the metal does not tear them up as before; but there must be very great and unnecessary friction, and very unnecessary labour is thrown on the clock.

8. In descending from the lightroom I found the chef (whose name I forget). He had been greatly disturbed by the long delay of the visit, which he had expected in July. I explained the delay by the

eclipse. He spoke with contempt of the Cap d'Ailly light, which he regarded as remarkable only for something picturesque in its position. All his admiration is fixed on the light of Belle Isle, which he describes as baving this peculiarity, that the cople or external window frame revolves with the revolving light frame. It is evident that there may be advantage in this. I conceive that this light might be well worthy of a visit, or at least of a special inquiry, principally for the engineering arrangements.

9. My examination on all these points of the Calais lighthouse was so complete, or at least so satisfactory to me, that I had no scruple in arranging for Captain Ryder's proceeding at once, as I have said.

10. The Cap d'Ailly light contains eight lenticular dioptric pannels (revolving). The upper catadioptric prisms are connected with and revolve with the dioptric pannels, and are in fact a continuation of the same system, the prisms being rings referred to *nearly* the same horizontal axis as that of the dioptric pannel. But the axis is not *exactly* the same, because the pannel of upper catadioptric prisms is hitched about two inches on the pannel of lenses. The lower catadioptric prisms are fixed horizontal rings.

11. The lamp is fed by pumps. Its height is adjusted every three weeks (this cannot be done with a fountain lamp, on account of the pipe communication). The oil is filtered through two inches of sand, in the lower store rooms, before first use and after each passage through the wicks. There are holes in the upper metal chimney into which there is a strong suction draft. The wicks were not cleaned from the night's work, and there was more than $\frac{1}{2}$ inch of char. On lighting the lamp the men could not get a 4-inch solid flame, but the average height was about three inches above the metals. The man played a good deal in adjusting the glass (a glass with a very gently sloping shoulder). I inquired whether he would like a rack-and-pinion movement, but he rather objected to it, for the following reason:—Sometimes the top of the glass melts (from the heat), and becomes en-

gaged with the iron chimney in such a manner that there would be difficulty in extricating it by a mere raising and falling motion without a rotatory motion, which the rack-and-pinion cannot give, but which the fingers can give.

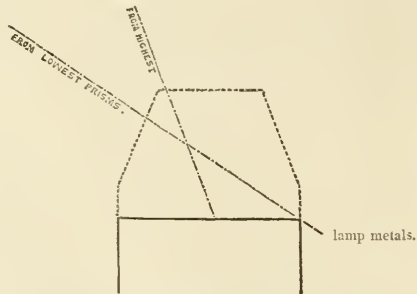
12. The name is Lepaute ; the date, I think, 1820.* The mechanism of rotation has the same fault as that in the Calais lighthouse (see paragraph 7, above).

13. I commenced the optical examination on the sea horizon, but after the loss of it I used a well-defined point of cliff, two or three miles S.W., on which the line of horizon was well known ; and this was found to be an excellent mark, because there was no uncertainty about its identification (which, with several parallel streaks on the sea and sky, is sometimes very difficult in the narrow prisms), and because I could instantly see whether the convergence forming the image was too near or too distant. When the horizon cleared again I examined it as a sort of verification, but found nothing wrong in my conclusions.

14. The image of the sea horizon formed by the dioptric lenses is 1·5 inch above the lamp metals, and very near the centre. The lens rings are very well worked, so that in viewing the horizon image over the lamp across the upper or lower parts of the lens, there is no sensible hitch or tooth from ring to ring, or from pannel to pannel; very different from the Start, but similar to Grisez; at the same time showing greater skill than is necessarily shown at Grisez, because the Cap d'Ailly pannels include each one eighth of the circumference, while the Grisez pannels have only one sixteenth of the circumference. These Cap d'Ailly pannels must (with a lamp flame exceeding three inches in height) be very effective, and must give a great blaze of light to the horizon and on the sea.

15. On trying the lower catadioptric prism, I found that the image of the sea horizon was, I think in every instance (Captain Ryder has taken accurate notes), thrown above the front edge of the lamp metals, not quite so high as I could wish, but respectably high, and these prisms really are efficient. They are the first that I have seen which deserve that epithet. I did not very specially remark the distance of convergence forming the image, but I am sure, from my general remarks, that it must have been very near the centre of the lamp. Every effective prism was examined.

16. On trying the upper catadioptric prisms I found that, with insignificant exceptions (for which I refer to Captain Ryder's notes), the position of the image of sea horizon may be thus stated. For the lowest prisms it is formed by rays whose directions fall on or a little above the rear edge of the lamp metals. For the highest prisms, it is formed by rays whose directions fall nearly on the centre of the lamp metal rings. For intermediate prisms, in intermediate directions. Thus the rays may be represented nearly as below :—



In every prism a brilliant light is sent to the horizon and a large body of light on the sea, I should

say four times as much as at Calais and six times as much as in any other light that I have seen. I think that, for my own entire satisfaction, I should have raised the path of rays even a little more ; but the general course here is so good that I would not on any account touch these adjustments. I ought to mention that we examined every one of the upper 88 prisms.

17. The accurate optical image of the cliff point was in all instances formed sufficiently near to the centre of the lamp. In some instances it was a little (perhaps two inches) in front of the centre ; in others it was as much in rear. The latter are usually those which in Captain Ryder's notes are marked as "confused." There is no ground of complaint on that account.

18. On the whole I pronounce this lighthouse to be in excellent adjustment, and far the most efficient that I have seen. M. Reynaud has reason to be proud of it.

19. The concave reflectors, which occupy the three land side spaces, are as dull as those in other French Lighthouses ; by no means so brilliant as an ordinary pewter pot.

20. On viewing the light in the evening from Dieppe (where it produces a very splendid effect), I remarked that between two bright flashes there are two intermediate little flashes, so faint that they would escape ordinary observation. Captain Ryder in verifying this was rather inclined to consider them as successive sudden degrees of elevation of light. I am not able to explain their origin.

I suppose that it will not be necessary for me to visit any more lighthouses.

I am, &c.

Admiral W. A. B. Hamilton,
&c. &c. &c.

G. B. ARMY.

Aberdeen,

10th October, 1860.

I HAVE to make the following Report on my examination of the Girdleness Lighthouse.

I arrived, with my son Hubert, at Aberdeen, on the evening of Monday, October 8th. On Tuesday morning I was visited at the house of John Webster, Esq., by Mr. Alexander Cunningham and Mr. Thomas Stevenson, Secretary and Engineer of the Commissioners of Northern Lights. With these three gentlemen and my son I proceeded to the Girdleness Lighthouse.

This lighthouse contains two systems of lights. The lower, at about $\frac{2}{3}$ of the height of the building, consists of 13 parabolic reflectors of the usual form, occupying with their light something more than the semi-circumference. I remarked in these that by a simple construction, which I have not seen elsewhere, great facility is given for the withdrawal and safe return of the lamps, for adjusting the lamps and for cleaning the mirrors. I made no further remark on these, but proceeded to the upper lantern.

The lighthouse here is that of a fixed dioptric and catadioptric light of the first order. It was erected by Mr. Alan Stevenson, 13 years ago (as I understood); the light-panels bear the name of Francois. The support of the light-frame is not a central pillar (as in most modern lighthouses), but a diagonal-braced frame supporting the circumference, which I greatly prefer. The lamp is 4-wick of the usual size, fed by pumps. The arrangement of the glasses is as at the Whitby and Foreland Lights, &c., with 6 rings of prisms below, and 13 above. The rings, both the dioptric and (as I believe) the lower catadioptric are bounded, not by vertical bars, but by inclined bars, all sloping one way; the oppositely inclined bars, necessary for firmness of mechanical support, being within the glasses. This appears to me to be a good plan, preferable to that of rectangular bars, both optically and mechanically. The quality of the glass is excellent, quite equal to that of any other which I have seen.

* Perhaps a mistake.

On examining the image of the sea horizon (which was remarkably clear), as formed by the dioptric band, it was at once evident that it (the image), was a little too high. With some sections of the band, it was about $1\frac{1}{2}$ inch (I believe, but I had lost my means of measuring,) above the metal; with others about $1\frac{1}{8}$. Mr. Stevenson produced a drawing of the lamp, on which the due position of the focal line was marked; and I showed him, and he at once assented, that the lamp was too low by about $\frac{3}{8}$ inch. The relative adjustment of different rings of the dioptric band, &c., was good. I then examined the lower reflectors, and at once saw what I have never seen before. The principles which I have been anxious to carry out regarding the due flood of light upon the sea are here *fully* carried out. In every instance the rays coming from the sea horizon pass above the front edge of the lamp metal by about or near half an inch, measured perpendicularly to the rays; and in the third reflecting ring from the bottom by a full inch. In fact my principle here is rather overdone, but this will be corrected by the same elevation of the lamp which corrects the action of the central dioptric band. Then I examined the upper reflectors, and here I found things very perfectly to my satisfaction. The rays coming from the sea horizon through the few lower prisms of the set pass well above the rear of the metals, those which come from the highest fall nearly on the centre.

Remarking how well the important upper set of prisms are adjusted, and that the adjustment which the central band and lower prisms seem to require would slightly injure the action of the upper prisms, I suggested to Mr. Stevenson that he should not raise the lamp by the full $\frac{3}{8}$ inch of which I have spoken, but perhaps by $\frac{3}{16}$ inch.

The lamp was lighted for my inspection, and I was able to point out more distinctly to Mr. Stevenson that elevation is required, and that the quantity required is small. The lamp flame had scarcely acquired its full height while I remained at the light-house, but it appeared to be approaching the French height. The lamp glass has the gently inclined contraction. I could almost imagine that the draft is too sharp, and that the lamp would burn better with holes in the chimney above the damper, so that the damper aperture would be wider.

This lighthouse has evidently been most carefully planned for the actual depression of the horizon, and has been maintained in good, though not quite perfect, daily adjustment; but the correction required, even now, is extremely small.

It is the best lighthouse that I have seen.

I am, &c.
G. B. AIRY.

Admiral W. A. B. Hamilton,
&c. &c. &c.

Royal Observatory, Greenwich,
20th October 1860.

MY DEAR SIR,
On returning hither I find a letter from Mr. Thomas Stevenson, which is interesting as regards the history of the manufacture of lighthouse optical frames, and which I therefore transcribe at length:—

“10th October 1860.

“I find on looking up our old books that the upper Girdleness Light was changed from the catoptric to the dioptric system in 1847.

“I forgot to mention, when speaking of Francois as the manufacturer, that in this, as in the other dioptric lights, all that was furnished in France was the glass prisms, and that these were afterwards all fitted together in brass frames made at Edinburgh under Mr. Alan Stevenson's immediate inspection. The only exception to this was the lens in revolving and he cylindric refracting belt in fixed lights, which

were always sent in their brass frames by the French manufacturer.”

I am, &c.
G. B. AIRY.

Admiral W. A. B. Hamilton,
&c. &c.

Royal Observatory, Greenwich, S.E.

MY DEAR SIR, 27 October 1860.

The enclosed letter from Mr. Chance, of October 26, will I think interest you. You will see how heartily and frankly he enters into our views.

I am, &c.

Admiral W. A. B. Hamilton, G. B. AIRY.
&c. &c. &c.

“Hamstead, Birmingham,
26th October 1860.

“MY DEAR SIR,

“WHEN I wrote to you from Whitby I expressed myself as doubtful concerning the advantages of adjusting dioptric apparatus by the image of an external object.

“I am now quite delighted with this mode. Not only does it secure greater accuracy of adjustment of the glass itself, but, what is very important, it affords greater facilities for adjusting the glass while the metallic frame is in its actual ultimate position in the apparatus.

“This is a great point to be accomplished, and whatever method the manufacturer may see fit to employ, he ought to be required (I think) to adjust the glass in the frames *after* those frames are fixed in their respective positions in the general apparatus.

“The system adopted until quite recently quite precluded the possibility of any such method, for the manufacturer was asked to supply (generally) only a number of *isolated* panels. For instance, one firm has at present an order for portions of an apparatus to be put together thus in detail, the framework being made elsewhere.

“Most truly yours,
“J. T. CHANCE.”

Royal Observatory, Greenwich, S.E.

MY DEAR SIR, 10th November, 1860.

I MAY perhaps consider that a proper time has arrived for the expression of my general opinions regarding the conduct of the English lighthouses. It was my first intention to submit to you answers to the specific questions contained in the printed letters of the Commission; but the examination of several lighthouses (of which examinations the details have been placed before you) has in some measure changed my views, and I think that I may do more complete justice to the subject by presenting my ideas without reference to those questions.

The inspection of the lighthouses to which I allude, has revealed some faults which deserve notice, partly from their own specific character, but more particularly because they seem to indicate an antecedent fault in the system of organization under which they have been produced. Referring generally to my former letters for these, I will proceed to state the course which I recommend, commencing with the personal organization.

1. It appears to me that there is no person officially connected with the Board of the Trinity House, who is distinctly responsible, either for the correct construction and erection of the illuminating parts of lighthouses with reference to their optical effect, or for the continual maintenance of those parts in proper adjustment. I think it absolutely necessary that an officer should be appointed, whom, for the sake of clearness, I will call “Optical Engineer,” whose special duties should be, not to construct or maintain the architectural fabric (which must be intrusted to the “Architectural Engineer”), except in indicating the requirements for elevation and other dimensions, and for store space, &c., but to construct and main-

tain in order the lantern-frame and lantern, the reflectors and refractors, and the machinery connected with them, the lamps and their mechanism, and the oil or other combustible.

2. The education of the "Optical Engineer" ought to be somewhat peculiar. First, he ought to be a trained mechanical engineer, competent to manage all the requisite combinations of cast and forged metals, and the frames and the mechanism constructed of them. Secondly, he ought to understand the science of optics, in a form which is rather unusual, and which none but a trained mathematician can master. The knowledge of optics which is possessed (for instance) by an optical instrument maker is quite useless for the construction of lighthouses. In no other working of glasses, except those for lighthouses, is the understanding of the effect of "different curvatures of a surface in different planes normal to the surface, receiving rays of light incident at high angles of incidence" absolutely necessary. Thirdly, he ought to know something of the glass-making; and ought to be perfectly familiar with the action of the large lamps under different modifications, as well as with lime-light, galvanic spark, &c., which it may be proposed to substitute; but this knowledge requires less of preliminary training, and will come with experience.

3. Supposing such an officer appointed, the questions of the printed letters may be considered as in proper train for solution. There will be a person who can lay down rules for constructors of lighthouse apparatus, or who can, if necessary, receive their suggestions (which sometimes may be guided by strict theory, and sometimes by practical convenience), and negotiate upon them; or who can arrange the special constructions required for difficult sea channels, for unusual elevations, &c. It is unnecessary to say that it would be his duty to see the arrangements properly carried out (a duty for which there appears to be, at present, no provision whatever). I do not therefore think it necessary, at this time, to enter into the details of those questions.

4. The principal part of the optical engineer's duty, for perhaps the first two years, would be the examination of existing lighthouses, with the view of ascertaining whether they are, in respect of permanent fittings (independent of daily adjustments by the lighthouse-keepers), in an efficient state. Where change is required, it will often be a question whether the change should be complete or partial. Thus, supposing it decided that the Start Lighthouse should be remodelled, it may be a fair question whether, in discarding its lenticular rings, its lenticular centres might not be retained. This review of lighthouses will be a troublesome business, but is, in my opinion, absolutely necessary. It is only thus that we can arrive at the elimination of such faulty curvatures as those in the North Foreland lower reflectors; of such veiny glass as that in the South Foreland lower reflectors; of such imperfect lamps as those which I saw in the Whitby lighthouses; and of such light-wasting adjustment as I have reason to think not uncommon.

5. Passing now to the material construction of lighthouses, I think that, upon the whole, the construction now adopted (with some parts purely dioptric, acting by refraction only, and other parts reflecting light by internal total reflection in glass, with scarcely any refraction) is a good one. I prefer the internal glass reflection, to reflection from any known metallic surface which has been actually tried in practice a sufficiently long time; first, because I believe the quantity of reflected light to be greater; secondly, because I think that by the subdivision of the whole reflecting surface into a moderate number of parts, greater accuracy can be given to the adjustments; thirdly, because if metallic reflectors were divided in the same way, they would bend and would be otherwise unmanageable. The curvatures, when the reflection is very oblique, require to be worked with exceeding care, which has not been given in every instance; but

the excellent cross-stroke machinery now introduced in the best factories, with the modes of testing practised in them, are competent to give the required accuracy.

6. There is a fault connected with the dioptric part which may hereafter prove a serious one, namely the chromatic dispersion. Its effects are sufficiently conspicuous to the eye; for, even where the quality of the glass is very good, it is impossible to see the horizon distinctly through the extreme edges. It would seem that the only way of diminishing it is to effect that direction of the rays of light by reflection; but the difficulty of ensuring accuracy of reflection at very oblique incidence is great; and on the whole I do not doubt that the angle at which refraction shall end and reflection shall begin has been fixed with good practical wisdom.

7. I can scarcely imagine that anything like achromatized prisms can be adopted with advantage. At the same time I throw out this whole subject of accuracy of refraction as one which deserves careful consideration.

8. In the treatment of the whole of this subject I insist upon accuracy of reflection or refraction of the beams of light as a principle which ought never to be relaxed. It is true that a large dispersion of the beam, perhaps five degrees, is produced by the size of the large oil lamps; but if the faults of the reflector or refractor produce some dispersion, that dispersion is entirely added to the dispersion depending on the size of the lamp flame, so that a dispersion which needs not to exceed five degrees may be amplified into nine or ten degrees, and the brilliancy of light thrown in a given direction will be diminished in the same proportion.

9. I think that the experimental use of the lime light in the streets, and that of the galvanic spark at the South Foreland lighthouse, have so far succeeded as to make the employment of these sources of light plausible. The question then arises, Can they be employed with advantage in existing lighthouses? Here the first consideration will be, Are the reflection and refraction in the existing lighthouses sufficiently accurate? In the case supposed above (Article 8) of a lamp dispersion of five degrees, increased by an inaccuracy dispersion of five degrees, the intensity of the beam of light was diminished to one half of what it ought to have been. But with lime light (and *à fortiori* with galvanic light), a lamp dispersion of less than half a degree would be increased by the same inaccuracy dispersion of five degrees, and the intensity of the beam of light in a given direction would be diminished to $\frac{1}{11}$ th part of what it ought to be. Without saying that there is this amount of inaccuracy dispersion in any of our lighthouses, I do, at present, think it doubtful whether their workmanship and adjustment are sufficiently exact to give the increase of optical effect which might fairly be expected from those intense lights. When the change of light shall be seriously suggested, a special examination of the lighthouse must be made.

10. Supposing such lights introduced with good effect, as regards the horizon and the very distant sea, it would be necessary to provide distinctly for the illumination of the nearer sea. For it must always be borne in mind, that the only way of giving intensity to a beam in one direction is to allow no light to pass in any other direction; and thus, to make the principal part of the reflectors and refractors available near the horizon, they must not throw any light on the near sea. This provision may be made perhaps in part by throwing a portion of the chromatic dispersion on the near sea, or in part, by giving peculiar curvatures to one or two of the less important (the lower) reflectors, adapted to that purpose. For arrangements of that kind the talents of the optical engineer will specially be required.

11. If these brilliant and minute sources of light should be successfully introduced, it would be possible, theoretically, to reduce the dimensions of the lantern to a very small size. Whether this could be done

practically is not quite so certain. Possibly the dimensions might (with due attention to the magnitude of lamp dispersion), be so far reduced that an error in position of $\frac{1}{4}$ inch would be nearly ruinous to the effect of the light. Could we depend on the adjustments being maintained so exact? If we could, there would be some advantage in these small light cases. The glass might be selected of perfect quality; the loss of light from passing through a great thickness of glass would be diminished; possibly the grinding of the curves might be more manageable, and therefore more accurate; certainly the expense would be diminished. On many accounts it is highly desirable to prosecute experiments on the easy and certain use of these sources of light.

These are the principal matters bearing on the practical administration of the lighthouses, which occur to me at the present time. Should any other ideas occur to me, I will have the pleasure of submitting them to you.

I am, &c.

Admiral W. A. B. Hamilton,
&c.

G. B. AIRY.
&c.

Royal Observatory, Greenwich, S.E.,
8th December 1860.

MY DEAR SIR,
I RETURNED from Birmingham on Tuesday evening, December 4th.

The business at Birmingham consisted chiefly in ascertaining the point of the lamp flame which might be considered as brightest, the trial being what part of the flame sent the most brilliant light to the screen at the end of the long gallery in Messrs. Chance's lighthouse factory. The optical apparatus used consisted of the bands forming one section of the dioptric part of a fixed light, every one of which was tried separately. The reflecting prisms were not mounted.

The first operation in the logical order (though not in the actual order of proceedings) was the verification of the zero of the scale by which the depression of the entire lamp frame was registered. For this purpose a small graduated standard was placed upon the lamp metals, and a gas burner was lighted at the bar near the distant screen (which bar was always adjusted to the height of the band under trial), and its image was observed upon the small standard as formed by different bands of the dioptric ring. In this manner it was found that for the broad central band, and for each of the upper bands, when the depression scale indicated 20 millimetres, the image fell upon 20 millimetres of the standard in the axis of the lamp; and thus in subsequent experiments the depression of the entire lamp to any particular reading indicated that the optical image of the distant screen zero was elevated by that reading above the lamp metals. For the lower bands the adjustment had been made to a constant reading, I think 18 millimetres above the front edge of the lamp metals; and this adjustment seemed to be fairly preserved, in correspondence with a depression of the lamp frame to 20 millimetres.

On the evening of Monday, 3rd December, the lamp being pump-fed, the lamp glass with gradually inclined shoulder (like the French lamp glasses), and the flame very fully high for an English lamp, but not so high as in the French lighthouses, but forming a very good solid body of brilliant flame; the experiments were tried upon one band at a time, simply by uncovering one band, covering all the others, and observing how the shadow of a horizontal bar near the screen, adjusted to the height of the band, fell with reference to the place of brightest illumination. And I was struck with the general delicacy of this apparently rough method of trial. A change of one millimetre ($\frac{1}{16}$ -inch) in the height of the lamp frame, was in every instance detected by the change in the appearance, as to whether the brightest part of the light fell or fell not upon the horizontal bar; and in many instances a change of $\frac{1}{2}$ a millimetre ($\frac{3}{16}$ -inch) was clearly discoverable.

The result of this evening's work was that the height of the brightest point of flame above the metals was from 21 to 22 millimetres; certainly not more than 22.

The various bands agreed very well in this: the upper bands (adjusted for intersection of axes of pencils to the same point as the special focus of the central band), and the lower bands (which, though adjusted on a different principle, as I have said, agreed in giving strongest light when the depression of lamp, or elevation of focus of central band above the lamp metals, was 21 or 22 millimetres). The chromatic aberration introduced some uncertainty; but the judgment of the eye became at last pretty decisive.

On the morning of Tuesday, December 4th, the experiments were repeated essentially in the same way; but the lamp was in a better state. Its flame was perhaps $\frac{1}{4}$ inch higher than on December 3rd. It was at a good French height, though not the highest. (I believe that a camera-obscura trace made by Mr. Campbell will give accurate information on the state of the flame.) The result now was that the point to be used for the brightest in the flame was 23 to 24 millimetres above the lamp metals; and I believe that, on the whole, we were all inclined to prefer 23 to 24. When we tried 28 millimetres the light on the zero of the screen was very much diminished. I felt very great surprise, and so I believe did all who were present, that Fresnel could have fixed upon such an element of adjustment. When the evil from thus throwing the light too high is aggravated by the dip of the sea horizon (Fresnel's 28mm. adjustment being intended for geometrically horizontal rays), which for 20' dip corresponds to about 5 millimetres in height of focus in lamp,—so that really 33 millimetres is the height to be tried, in comparison with 23 or 24, which we found best,—the loss of light is absurd.

A polygonal lens was then mounted; and, generally speaking, it seemed to lead to the same conclusions. But the light upon the screen could not be observed with so much accuracy, because the lens produced a rude image of the lamp flame, and the eye was distracted by the images of the bright edges of the various cylinders of flame produced by the separate wicks, and by the colours which accompanied them.

It appears to me that two results of considerable importance have been attained in these experiments. (1.) We have ascertained with much accuracy the height to which the sea horizon focus ought to be adjusted. (2.) We have acquired a very good idea of the degree of accuracy at which the adjustments ought to aim.

After finishing our proper experiments we saw Mr. Stevenson's light lantern for MacArthur's Head, which is a remarkable instance of the arrangements which an optical engineer of lighthouses ought to be prepared to make when need requires. We also saw the frame of the Smalls Fixed Light, which an agent of Messrs. James Walker and Burgess came to examine; it is framed, for optical convenience, with inclined uprights; but I was not satisfied with their bracing.

We also saw the plans (apparently yet imperfect) for the galvanic spark light to be mounted on the Dungeness Lighthouse.

I had nearly omitted to mention one circumstance regarding the lamp. After two or three hours burning of the lamp on the evening of December 3rd, it was found that the innermost wick was charred black two inches down. The outermost wick was very little charred. It would be desirable, if possible, to prevent this.

I am, &c.

Admiral W. A. B. Hamilton,
&c. &c. &c.

G. B. AIRY.

REPORTS, &c. BY PROFESSOR FARADAY.

REPORT, &c. to the DEPUTY-MASTER and BRETHERN
of the TRINITY HOUSE.

The Royal Commission on Lights, &c. having desired to meet the Brethren of the Trinity House at the North Foreland and Whitby Lighthouses, with certain other persons, such as the manufacturers of the apparatus, the representatives of the Irish and Scotch lighthouses, the Astronomer Royal, &c., for the purpose of making certain practical communications to them, which could not be so well done by writing or elsewhere, such meetings have taken place. The one at the North Foreland occurred on the 2d of August, when there were present Admiral Hamilton, Captain Ryder, Dr. Gladstone, the Astronomer Royal, and Mr. Campbell of the Royal Commission; Admiral Gordon, Captain Close, Captain Bayly, Captain Weller of the Trinity House; Sir James Dumbraun of the Irish Board, and Mr. Halpin and Captain Roberts, Mr. Stevenson of the Scotch Board, Mr. Soutter, of Paris, the maker of the apparatus, with Mr. Wilkins, and myself. The other at Whitby occurred on the 9th of the same month, when the same persons were present, with the exception of the Astronomer Royal, Captain Weller, Sir James Dumbraun, and Captain Roberts, and the addition of Captain Nisbet, E.B. Trinity House, and Mr. J. Chance, the manufacturer of the apparatus, with M. Masselin. I was there on the part of the Trinity House as their scientific adviser in experimental lights; and although I do not wish to assume the character or responsibility of optical or civil engineer, I feel it my duty at the call of the deputy master, to give my impression and conclusions. Having received no descriptive written document from the Royal Commission, I may perhaps pass by some points requiring attention, unawares.

The object of the Royal Commission was, I believe, to point out the necessity of a final examination of the optic apparatus in the lighthouse itself after its erection, and the demonstration of a mode of making that examination in a practical manner, which I may call the method of the Commission. The object of the optic apparatus in a lighthouse is to convey the rays from the source of light to the sea horizon, or to the parts of the sea between that horizon and the shore, in the most abundant degree possible, and in the most favourable manner. This effect is obtained by a certain position and adjustment of the parts of the refracting and reflecting apparatus, and whether these are right in this respect may be ascertained by a process in some degree the reverse of the illuminating method. Thus, suppose the lamp is lighted, a given bright spot in its flame selected, and a given piece of the glass apparatus adjusted, so as to transmit the light passing through it, from the chosen spot to the sea horizon; then if the adjustment be right, an observer placed on the other side of the flame, and looking through the spot and the glass, will see the horizon; and this is an observation easily made in the daytime, either with the flame actually existing, or with indicating gauges at the burner (as the edge of a card for instance), representing given or selected parts of the flame. If the horizon does not appear in the right place the adjustment is wrong. The same kind of test may be applied to every part of the apparatus in turn, whether refractive or reflective, in respect of any part of the horizon or the sea or the sky, and in respect of any part of the flame or luminous object. A luminous point being selected, that place which the eye sees through it will be the place to which the rays issuing from it in that direction, will proceed.

This appears to me to be an excellent practical application. In principle it is perfect. The application, however, cannot be equally perfect, because of the inevitable imperfections of construction. Still the quality of the glass and its workmanship have arrived at such a degree of excellence as to justify the application of this refined kind of inspection; which may be anticipated and worked up to, by processes applicable in the manufactory.

Assuming that the apparatus is as perfect in its execution as can be expected, then the causes that may interfere with the due effect (and chiefly by mal-adjustment) are several. First, those connected with the *lamp and flame*. The Fresnel lamp has a burner and cottons having a horizontal width of $3\frac{1}{2}$ inches in diameter;—the flame, as it rises from this base is obscure above and near to the cotton, then becomes luminous and powerful, and contracting as it rises, usually ends in a series of forked tongues. When supplied by an overflowing lamp urged by the draught of a good chimney, the bright part of the flame may be from $2\frac{1}{2}$ to 4 inches from the bottom to the top of the chief tongues of flame; these latter having no smoke at their tops; and the horizontal section passing through the widest and brightest part of the flame, will be from $\frac{5}{8}$ to $\frac{9}{8}$ of an inch above the burner. It is assumed that this section should coincide with the focal plane of the lenticular bands, or merely refracting part of the apparatus; for then the most powerful rays proceed in a horizontal direction, and will fall on the sea horizon when the light has little or no elevation above the sea. All the light which emanates below that plane, and passes through the lenticular bands, will be thrown up into the sky above the horizon, but all that emanating from the great body of the flame above that plane, will be cast over the sea between the horizon and the shore, doing good service to the mariner.

The selection of this plane, or of the point in the centre of the flame coinciding with it, which is called the focal point in respect of the refractors, is of great importance. By numerous experiments and trials in France it is considered as 28 mm. or 1.05 of an inch above the burner. Now the brightest horizontal section of the flame, may be 1.12 inches above the burner with a well arranged overflowing lamp, or only 0.75 of an inch above it, with a low flame and non-overflowing lamp; and the adjustment in height of the lamp which would suit the first and send a fine body of light from the upper part of the flame over the sea, would, with the latter, send little to the sea, and the greater part of the light to the sky; so that not merely has the adjustment to be attended to, but also the lamp suited to the adjustment.

As far as my observation goes, the lamp should overflow freely, so that only one fourth of the oil that passes over and through the wicks should be burnt. It should, in the case of a first order lamp, have four wicks, and a chimney of glass and iron 6 feet high. As much oil as possible should be burnt without smoking, for when in a good state the light is as the oil burnt. The lights at Whitby had not overflow lamps, and only a certain amount of oil could be burnt, and a certain height of flame (lower at the South than at the North Lighthouse) be obtained. By making the oil overflow and raising the wick, the flame was raised at the base, but began to smoke. By virtually lengthening the chimney, through the application of paper valves, the whole flame was raised both at the base and at the summit, and the combustion very greatly improved, and that continuously. But the adjustment of the optical part of the apparatus fit for the one state of flame would not be fit for

the other. Being examined in the manner proposed by the Commission, if the combustion were low, the ray proceeding from the eye to the horizon would be much too high in the flame, whereas with a full and proper flame, it might pass in the best direction; for the difference in level of the brightest sections of two such flames may be as much as $\frac{3}{8}$ of an inch, and every diminution in the good condition of the flame, whether from the construction of the lamp or inattention, tends to rob the flame at the upper or sea supplying part.

In respect of the reflectors circumstances are different. The whole of the flame radiates light towards each of the *upper reflectors*. If the eye be so placed (as in the Royal Commission process), as to see the horizon through the flame, in the middle of one of the reflecting prisms, then all the flame above that line will throw its light into the sky, and only that part below the line will throw its light on to the waters. Hence the line through the flame, or rather through its projection at the reflector, should go through a bright and abundant part of it, and should also leave as much as possible of the flame below that line, since that is the part which radiates light to the sea; i.e., the observer's ray should be taken as far back towards him, and as far up, as is consistent with a good line of flame for the horizon, and then the reflector ought to be adjusted, so as to throw this light which has reached it, onward in the right direction. As regards the upper reflectors, generally a point in the centre of the flame, 1.55 inches above the burner, is from careful experiment considered as that which gives the best result, and is called the focal point for the upper reflectors, being common to all.

In respect of the lower reflectors, matters are very different. The burner and cottons cut off much of the light of the flame from them. With the best flame one half of the light is thus lost, and with a low flame only a fourth or a fifth may pass to them to be utilized. The line of sight should, as regards the observer, be taken as far forward, and up, as is consistent with its passing through a bright part of the flame; for here again it is the part of the flame below this which sends light to the sea, whilst the part above casts its rays into the sky. In the French experience and practice, not one focal point but several foci are taken for the different reflecting prisms. These are points in a vertical line in the centre of the flame, the lowest focus is for the upper reflector, and the highest for the lower reflector, and they are respectively at the following heights above the burner, 38, 42, 47, 53, 60, and 68 millimeters.

The lamp, optical apparatus, and adjustments which I have referred to, have had reference to a horizontal line; and it is so, that nearly all the apparatus made in or for England have as yet been so constructed; but the *sea horizon* does not correspond with a line horizontal at the lighthouse, it forms an angle with it, and that so much the greater as the light is higher above the level of the sea. At the North Foreland the two make an angle of about $14^{\circ}.2$, and at Whitby of about $16^{\circ}.5$. Hence, if the chief ray of light be sent horizontally, it will pass over the sea and be wasted; and, indeed, more light with it, even the $16^{\circ}.5$ seconds, which ought to fall on the sea. This condition is seen at the Whitby lighthouses by the Commissioners' mode of examination a little modified. To correct this error for the lenticular bands, it would be sufficient to raise the lamp an equal number of minutes, (about $\frac{1}{4}$ of an inch for Whitby); but such a proceeding would increase the error for the reflectors both above and below, and can only properly be met by instructions to the maker of the apparatus at first.

The French Authorities only take account of this difference between the sea and true horizon when the height of the light is 60 meters (about 200 feet) and upwards above the sea. For my own part I do not see why it should not be taken into account for an height of 50 feet and upwards. Twelve or thirteen

years ago the Lundy Light had its chief rays sent to the sea horizon, and I made an instrument which was used by Mr. Wilkins for the proper adjustment of the reflectors. Since then the reflectors have been changed for others on the catadioptric principle, and these have their rays directed horizontally as at first, and the same rule has held ever since. Mr. Chance tells me he is *now* constructing apparatus with the rays directed to the sea horizon.

Cases may arise where a high light, not being a leading light, might better have its chief ray sent, not to the extreme sea horizon, but some intermediate distance, where in hazy weather the light might require to be in some degree concentrated. Such cases are nautical in their nature, but if they occur, instructions should be given to the maker beforehand, since the correction or adjustment cannot properly be made afterwards.

The first application of a new and searching method of examination, not applied until after the workmen have been fitting and handling the heavy parts of the apparatus in the lantern of the lighthouse may discover either derangements of the whole, or of parts. From the expressions of the makers, M. Santter and Mr. Chance, I understand that these can be rectified in apparatus already erected, and can be prevented in apparatus to be made hereafter, so that the test proposed makes no undue claim on the manufacturer.

The Royal Commission when at Whitby, pointed out certain deficiencies in the illumination of the sea; and the waste upon the sky of a portion of the light which the lamps sent to the glass apparatus, both results being indicated by the mode of day examination. The lower reflectors especially appeared inoperative, not merely because only a little light could in any case fall upon them, but because, if a good lamp had been in the centre, the adjustment of the reflectors was out. A like condition of matters was indicated when at the North Foreland.

Of the two lights at Whitby within 258 yards of each other, the North Light lamp is much better than that at the South Light; it gives a higher flame and burns more oil, and the appearance at sea corresponds to this difference. But besides that, there are differences in adjustment. An excursion to sea at night on the 9th was made, and at a given signal the whole of the lenticular band of the North Light was covered up, only the reflectors being left, to compare with the whole of the South Light as a standard. In this state the North Light was nearly equal to the South Light in brilliancy, and in certain positions of the ship was quite equal to it. The light was thus covered up and uncovered again, twice, and the observations were made at distances of four and seven miles. They showed that the upper reflectors at this house were well adjusted to cast the light upon the sea. Here, therefore (at Whitby), it appears to me it would be best to make any proposed changes, for they could be carried out at the South Lighthouse by Mr. Chance, the maker of the apparatus, who was present and who understands every point in the matter, and the North Light could be left as a standard by which to estimate the improvement gained.

I am persuaded that the condition and character of the lamp has a most important influence over the results that have been and are to be acquired. Some persons call a flame $3\frac{1}{2}$ inches high, which I and others would consider as only $2\frac{1}{2}$ or 2 inches in the effectual part. Some persons count from the top of the burner to the top of the tongues of flame, whereas the bright luminous part of the flame often begins $\frac{2}{3}$ of an inch above the burner, and as a body ceases, it may be an inch or even two inches beneath the top of the longest smokeless tongues. The difference in the consumption of oil at the different lighthouses shows the great diversity existing amongst the flames of different lamps; to which, if one common standard of adjustment in respect of the optic apparatus be applied, it must as often be wrong as right. It appears to me that the first thing is to have an excellent and

constant lamp, and that *all lighthouses* of the same order should have a lamp of the same quality ;—that the glass chimney employed should have a gradually rounded shoulder and not a sharp square one, which greatly disturbs the direction of the light ;—that when the best form has been attained it should be adhered to ;—and that the glass and iron chimney together should be continuous for 6 feet. Then the practicable constant size and condition of the flame of such a lamp should be determined, and a general gauge and measure of the bright part of it and its position in relation to the burner, be supplied to each lighthouse (which could easily be done by an outline drawing on open wire gauze, or otherwise), that the keeper may report whenever the lamp falls short of its required duty. Having such a lamp it should be ascertained whether the foci for the adjustment of the optical apparatus at present adopted are the best for it, as the French Authorities believe, or whether they could be advantageously altered ; and then apparatus constructed in future should be made in conformity thereto, and finally tested in their place by the Royal Commission process.

If Mr. J. Chance were authorized to procure such a lamp for the South Whitby Lighthouse (that is, a lamp which being excellent could be easily and certainly repeated), and were then to adjust the optic apparatus to it, the result could easily be tested by a comparison with the unaltered North Light ; but it would be desirable to be able to ascertain separately, as far as may be, the effect due to the improved lamp, and that due to the re-adjustment of the glass.

With respect to the North Foreland Lighthouse, M. Sautter, the manufacturer, met the Royal Commission and the Trinity Board there, and heard and saw all that passed. I understood him to admit freely the principle advocated by the Royal Commission, but to assert that the apparatus was in perfect adjustment for a *proper lamp*. Setting up the gauges at the burner, according to the focal places assumed and adopted in France, the apparatus, with the exception of one or two prisms, certainly was in beautiful adjustment to them. For my own part, I am of opinion that in relation to the generality of lamps as I have seen them burning, the foci (at least of the lenticular part) are taken too high. The chief focus at the North Foreland has been placed 28 millimetres above the burners. As I saw the lamp burning on the evening of Wednesday the 8th instant, and the keeper said it was in its right and usual state, the chief plane of light was not above 22 millimetres above the burner ; and if account be taken of the dip of the sea horizon, which is here about 14".2, the burner ought to be raised on that account 4 millimetres more, making the distance below the focal plane 18 millimetres only instead of 28. If, however, the lamp were raised enough for the correction of this difference, it would greatly throw out of adjustment both the upper and lower reflectors.

M. Sautter is of opinion that the apparatus requires no adjustment, but is correct for a proper overflow lamp. He has full confidence in the French authorized foci. He is, however, ready to raise the lamp and to readjust the reflecting prisms to any degree the Trinity House may require. Though I think that the foci may perhaps be altered with advantage, and intend making an investigation of their places when a good standard lamp is employed, if the Trinity Board desire it, I am not prepared to go hastily in opposition to the conclusions carefully drawn from theory, experiment, and long practical application by the authorities in France ; and, therefore, am of opinion that if MM. Sautter and Wilkins place a proper lamp in the lighthouse, and leave it and the optical apparatus in that state of adjustment which the former approves of, and will be responsible for, the determination of any further change there, may remain until after the effect has been ascertained of the alterations at Whitby, the changes at the North

Foreland itself, and the re-examination of the places of the foci.

(Signed) M. FARADAY.

Royal Institution,
16th August 1860.

REPORT ON FOCAL POINTS.

Royal Institution, 1st September, 1860.

IN reference to the examination (proposed at the end of my report of the 16th August 1860) of the focal points heretofore adopted in France and also in this country, I have to state that from considerations founded upon the size of a good lamp flame, I came to the conclusion that the focal point for the lenticular or dioptric part was right, or very nearly so, but that those adopted for the upper and lower reflectors were much too low. Those for the lower reflectors may be represented by a common intersecting point, 10 mm. above the burner, and 48 mm. from the axis on the side towards the reflectors. My first judgment was to alter this point, by raising it so that it should be 20 mm. above the burner, and 50 mm. from the axis. Mr. James Chance invited me to see two fine first-class lights for Russia, one of which, being a fixed light, he had of his own judgment and experience, adjusted to foci different to the above. I found the effect of this alteration to be very excellent, and I found, moreover, that his numbers and mine were so near to each other as to render them, in effect, coincident. I consider the result, therefore, a full practical confirmation of the numbers, and I do not hesitate to recommend this alteration for the adoption of the Trinity House.

With regard to the upper reflectors, my preliminary judgment was for a far greater change. The French authorities (which we in England have thus far followed) is for a common focus for all the upper reflectors placed in the axis of the flame, and raised 38 mm. above the burner. I think the common focus ought to be 27 mm. above the burner, and 32 mm. from the axis on the side from the reflectors. I have endeavoured experimentally, with a good lamp, to establish or correct this estimate, and my results gave a point 30 mm. above the burner and 32 mm. aside from the axis as an excellent place ; but I desire to carry out this change upon a whole panel of upper reflectors before I recommend it finally to the Trinity Board.

(Signed) M. FARADAY.

To P. H. Berthou, Esq.,
&c. &c. &c.

REPORT ON EXPERIMENTS at MESSRS. CHANCE'S WORKS and at WHITBY, in relation to focal points.

I HAVE been to Birmingham, and worked for two days with Mr. James Chance upon the determination of the best focal points for the upper reflecting prisms. I still see reason to expect much improvement by the change referred to in my Report of the 1st instant, and now propose to carry out that change experimentally at Whitby.

For this purpose I propose (as before) that the North Whitby Light be left untouched for a standard. That Mr. J. Chance provide for the South Light a good overflow lamp, with a continuous chimney 6 feet in length from the bottom of the glass, and adjust it so that a ray from the sea horizon passing through the middle of the lenticular zone shall intersect the axis of the lamp at a point 28 mm. above the burner. That the lower reflecting prisms of all the four octants, *save the third*, counting from the north, be adjusted to the sea horizon, from a focus 20 mm. above the burner and 50 mm. from the lamp axis towards the reflectors. That the upper reflecting prisms (save those of octant No. 3) be adjusted to the sea horizon, but from different foci ; the north panel or No. 1, to a focus 20 mm. above the burner and 30 mm. from the lamp axis, on the side from the reflecting prisms ; panel No. 2, to a focus 28 mm. above the burner,

and 30mm. aside; the south panel, or No. 4, to a focus 28mm. above and 40mm. aside. The octant No. 3, to have both the upper and lower reflecting prisms adjusted by the French foci, and not to the sea horizon but to the true horizon.

I then propose to go to sea at night time, and examine the effect of these different adjustments at distances up to 18 or 20 miles, moving on some such course as that a plan of which is herewith sent (marked P, *see diagrams, next page*), that the effect of each adjustment may be observed and compared with the North Light; and I propose that at the extreme distance the lenticular band shall be screened off, so that in returning the effect of the reflecting prisms *only* shall be seen and compared, the northern light still remaining unchanged.

This sea trip will probably decide the best arrangements, but if cause appears for trial of any other foci, or any other arrangement, such arrangements can be made in a day or two, and a second night examination at sea be made.

The expense incurred by the experiments at Birmingham, by those now recommended at Whitby, and for apparatus I have had occasion to order, will probably not exceed 300 pounds.

I have, &c.
(Signed) M. FARADAY.

Royal Institution,
14th September 1860.

REPORT ON EXPERIMENTS AT WHITBY in relation to the FOCAL POINTS OF LIGHTHOUSE APPARATUS.

The experiments referred to in the report of the 14th of September have now, by the authority of the Trinity House, been carried out, not only in London and Birmingham, but also at Whitby, and the Deputy Master, with certain of the Brethren, have there entered into an examination of the results.

The South Light at Whitby was inferior, on the occasion of the former visit, to the North Light, though both lamps were of the same construction. That in the North house was left unchanged, to serve as a standard. That in the South house was changed for one with four wicks, and a plentiful overflow, and the light it now gives is not merely considerably more than before, but more than that of the North Light. It has burnt well from the first. The average proportion of oil consumed in a fortnight is 15 pints for the South Light, and 13 pints for the North Light per 12 hours. These quantities accord with the proportion of light which they really give.

In reference to the focal changes and adjustments for the experiments, the following arrangements were made. There were four equal octants or eights of glass apparatus in the Whitby South Lighthouse, with a central lamp to the whole. Each had its three parts; the lenticular band, the upper, and the lower reflectors. The lenticular part is the most powerful, the upper reflectors come next, and the lower reflectors are last. The adjustment is made, first, by the elevation of the lamp for the lenticular band, and after that by the position of the prisms for the reflector part. The lenticular part is (in the Whitby case) adjusted for all the octants at once. The French focus for this part has been adopted, namely, 28 mm. above the burner, but the French authorities send the chief ray on a horizontal level for a light of such a height as Whitby, whereas I have sent it down to the sea horizon. No. 3 octant was selected to represent the French adjustment, but it was impossible, whilst regulating the lenses of the other octants, to separate this from them, so that it had an advantage in the comparison as respects this lens part—as to the reflectors, however, the focus (or common focus) for the upper set is 38 mm. above the burner in the axis of the flame, and 9 mm. up and 50 aside for the lower set. These were adjusted

accurately in the lighthouse to the *true horizon or dead level*.

The other octants had each a pair of common foci for the reflectors, as follows:—

No. 1 (p) 20 mm. up and 30 aside upper reflectors and (t) 20 up and 50 aside lower reflectors. (*See wood cut, page 94.*)

No. 2 (e) 28 mm. up and 30 aside upper reflectors and (t) 20 up and 50 aside lower reflectors.

No. 3 (g) 38 mm. up and 0 aside upper reflectors and (κ) 9 up and 50 aside lower reflectors (French).

No. 4 (r) 28 mm. up and 40 aside upper reflectors and (κ) 9 up and 50 aside lower reflectors.

The octants 1, 2, and 4 had their adjustments made to the *sea horizon*.

The intention of all these arrangements was to discover and establish (what was expected on principle) that much light, hitherto thrown up into the sky, might be disposed of on the sea between the distance and in shore, without any diminution of the light on the sea horizon; and that if particular regions in certain directions short of the horizon required an especial amount of light, what special or common foci were proper for such a purpose.

The night sea voyage was so arranged that by turning the apparatus the various octants (with all the light on) could be observed at different distances as the ship went out, the effect of the change from the one to the other being remarked, and at the same time a continual comparison with the unchanging North Light being made. On returning towards land the lens part of all the octants was blinded, so that a like comparison of the reflectors *without the lenses* could be made over the same series of distances.

When in shore, *i.e.*, about a mile or a mile and a half off, the octants 1, 2, and 4 surpassed the French octant, as was expected; the same effect continued when further out, but diminished in proportion. At 10, 12, and 14 miles out the difference between the octants diminished, but the French octant never surpassed No. 2 or No. 1, and was, as some thought, rather beneath them. The constant North Light was most important in helping to settle these differences. When the lenticular bands were screened off, the reflector bands alone gave bright light, but there were differences of the same kind as those already described, though *greater* in proportion.

Every one present made their observations for themselves, but, I believe, with a like result. I had expected No. 2 to be a best if not *the* best arrangement, and I am happy to believe the Deputy Master and Brethren came to that conclusion, since they directed that it should be the type and pattern of adjustment for all the octants of both the Whitby Lighthouses.

Like observations to those just described had been made on shore, and with the like result, but we had not then the same advantage of observing at very long distances, nor that of comparing with the standard North light.

On the Monday we wrought at the Lighthouse for the purpose of verifying or correcting the focus for the *lower reflectors*. Mr. James Chance, in making the adjustments, found that numbers varying somewhat from those I had given, and even more from the French numbers, caused the rays to be more parallel; and, as they were to supply the sea horizon, such parallelism would be an advantage. The numbers were (L) 25 mm. up, and 40 aside. (These numbers were used on the night of the sea observations.) By trial I became satisfied of the reality of the advantage, and recommend these numbers to be adopted for the lower reflectors.

All the time we were at Whitby (eight or nine days) Mr. Chance and myself were occupied in learning, practising new methods of adjustment and correction, and using new instruments; and I cannot say too much in thanking Mr. Chance for the earnest and intelligent manner in which he has wrought with me in the experiments, working and thinking every

point out. The method of adjustment is now so perfect that the authorities can hardly require more accuracy than the manufacturer can ensure. The Trinity House may direct at its pleasure that the light of one part of an apparatus shall be thrown chiefly in one direction, as the sea horizon, and that of another part in another relative direction, as nearer to the coast, and I have no doubt that if the electric light or any other of the compressed intense illuminations be hereafter adopted, the principles and methods of adjustment now devised and carried into practice will prove of very great and special advantage.

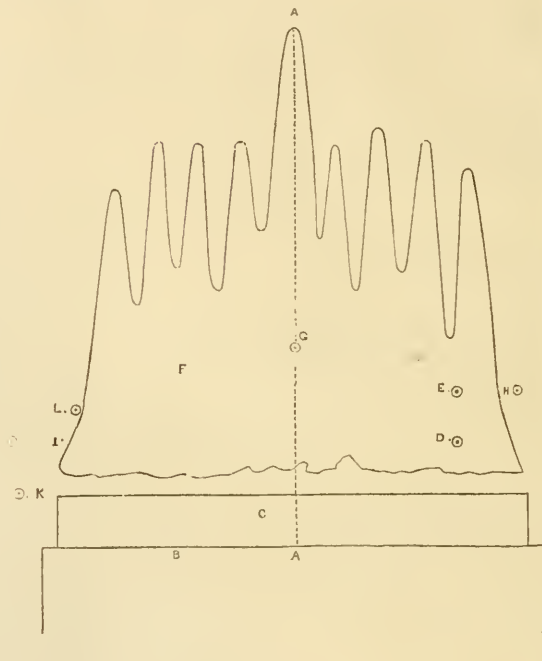
Royal Institution,
19th October 1860.

(Signed) M. FARADAY.

POSITION of the experimental common foci for the Upper and Lower Reflectors supposed to be situated on the left-hand side of the flame represented in the figure.

THE words "common focus" are intended to express that point from which the rays which lie in a plane passing through it and the axis of the flame and apparatus, and also through the middle of the pieces of glass associated in one panel (as of the upper or lower reflectors) shall be made by adjustment to proceed to any given spot, as for instance a point on the sea horizon.

- (B) The burner, from which the heights of the foci are set off.
(C) The cotton.
(F) The bright part of the flame.
(A A) The axis of the flame from which the side distances are measured.
(D) 20 millimetres up, 30 mills. aside.
(E) 28 " 30 "
(G) 38 " 0 "
(H) 28 " 40 "
(I) 20 " 50 "
(K) 9 " 50 "
(L) 25 " 40 "



REPORT ON THE SOUTH LIGHTHOUSE AT WHITBY.

Royal Institution,
20th November 1860.

THE adjustment of this Lighthouse has been completed by Mr. James Chance according to the instructions received from the Trinity House:—the lenticular part from a common focus 27 or 28 mm. above the burner, the upper reflectors from a common focus 28 mm. up and 30 aside, and the lower reflectors from a common focus 25 mm. up and 40 aside; the mean ray being sent to the sea horizon. The only exception is in the north lenticular panel, the sea horizon focus of which is 25 mm. above the burner. The present condition of the experimental investigation of the lenticular part of the apparatus makes me not sorry for this circumstance.

The character of the lamp and its flame is most essential. The latter ought to be well watched and cared for. I find it very difficult to devise a sure check on the attendance. A pint and a half (or somewhat more) of oil ought to be burnt every hour in a first order lamp with a brilliant flame; but it is difficult to found an effectual check, either upon the quantity of oil which disappears, or upon the time of the keeper's visits to the lamps.

I have not seen the lighthouse since the adjustments were made, but they were made by Mr. James Chance himself, and I have the fullest trust in him. I enclose his report.

Everything thus far confirms me in the opinion that what the Trinity House has done in this case has been done well; that every future case can be considered in relation to the adjustments necessary for it from the very beginning, and that that adjustment can be carried out with certainty.

(Signed) M. FARADAY.

REPORT OF ALTERATIONS made in the DIOPTRIC APPARATUS at the SOUTH LIGHTHOUSE at WHITBY.

Glass Works, near Birmingham,
17th November 1860.

1. Height of the lamp in relation to the refractors.

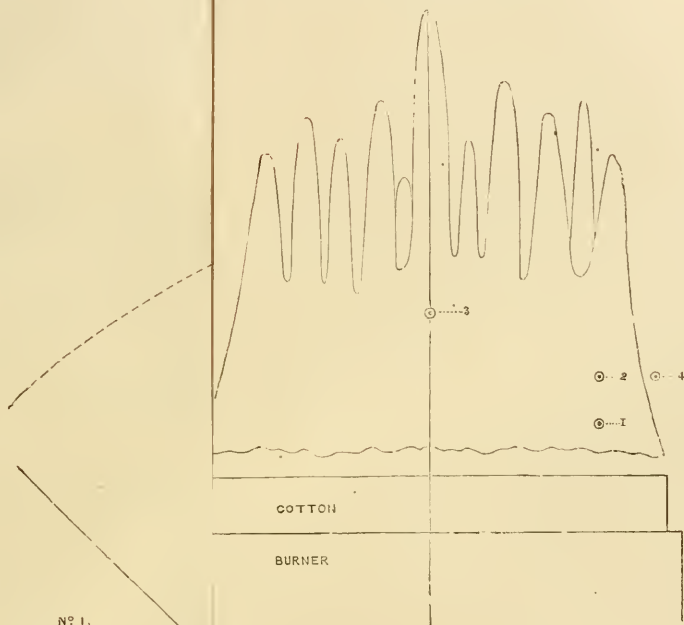
The lenticular panels have not a common focal plane; and as I had no authority to readjust the lenses, the lamp has been so placed that 28 mm. is the *maximum* distance of the burner below the sea horizon focus of any refracting panel.

The 2d, 3d, 4th, and 5th panels, counting from the north, have their respective sea horizon foci from 27 mm. to 28 mm. above the burner, whereas the 1st panel has its sea horizon focus only 25 mm. above the burner.

I doubt not that this last panel is better placed for sending the brightest light to the sea horizon than the other three (though not intentionally).

[To face page 94.]

REFLECTOR FOCL.



Nº 1.
20. UP.
30. ASIDE.

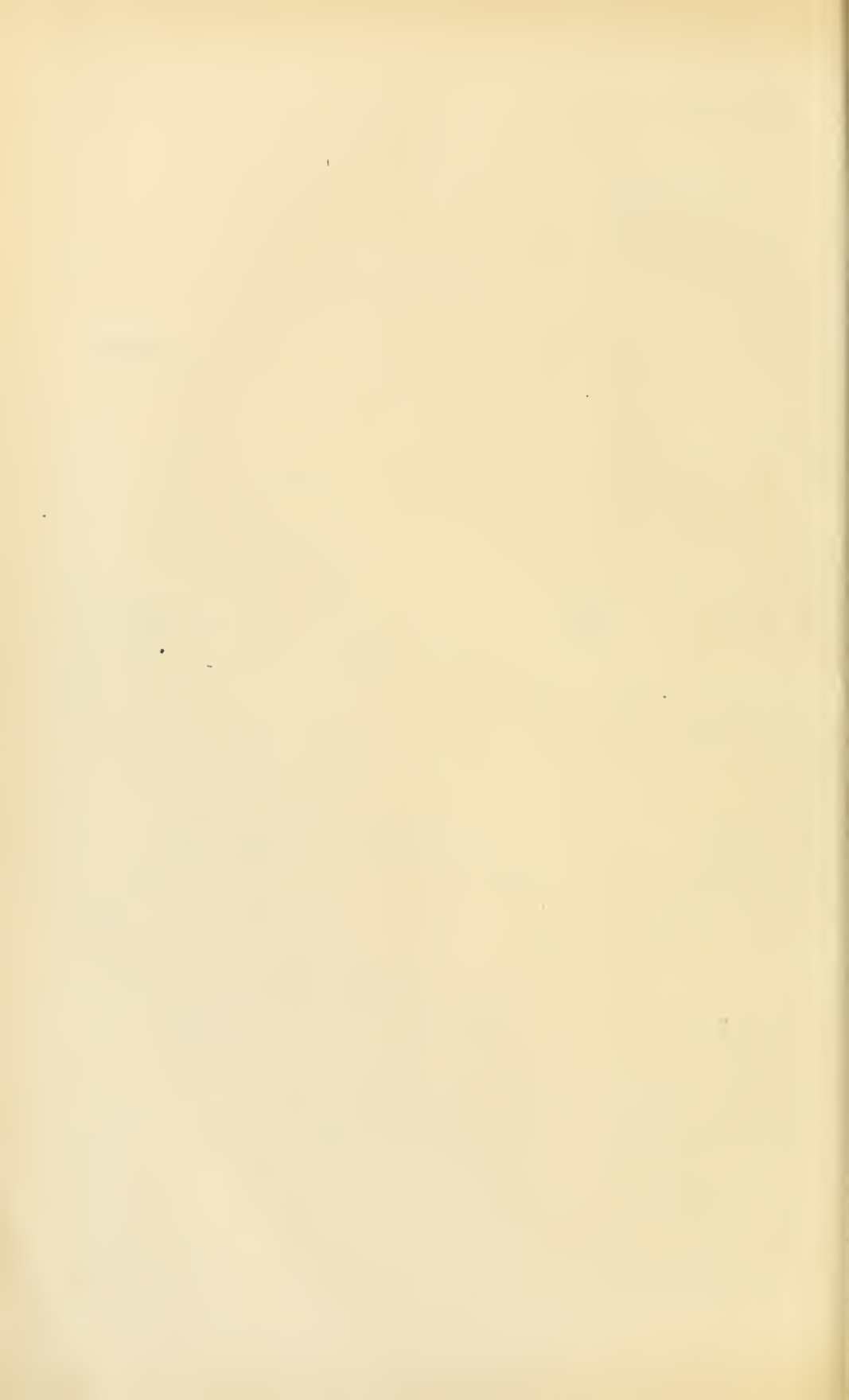
Upper Reflectors :—

1. 20 up 30 aside, new.
2. 28 up 30 aside.
3. 38 up 0 aside, French.
4. 28 up 40 aside.

Lower :—

5. 11 up 48 aside, French.
6. 20 up 49 aside, new.

Report of Experiments at Whitby, 19th October 1860.



The due position of the burner, both vertically and horizontally, is defined by the intersection of two wires or strings to be passed and stretched diametrically through two pairs of holes fixed permanently for that purpose on the uprights of the apparatus.

2. *Upper Reflectors.*—The sea horizon focal line of each prism has been made to pass through a point 25 mm. above the burner, and 30 mm. behind the axis of the system.

3. *Lower Reflectors.*—The sea horizon focal line of each prism has been made to pass through a point 25 mm. above the burner, and 40 mm. before the axis.

4. *Lamps.*—The south lighthouse is at present provided by me temporarily with two good mechanical four wick lamps, and the requisite supply of surplus burners, &c. &c. I purpose, however, sending ultimately two pressure four-wick lamps, as I prefer the greater simplicity of construction of this kind of lamp.

(Signed) JAMES T. CHANCE.

MEMORANDUM.

The metallic reflectors at the South Whitby light are not being used at present in consequence of the injury which the reflected heat of the flame, now so much increased, causes to the burner. This is a matter for future investigation.

(Signed) J. T. C.

To Professor Faraday,
&c. &c.

REPORT OF EXPERIMENTS AT BIRMINGHAM ON THE FOCAL POINTS OF THE LENTICULAR PANEL OF A FIXED FIRST ORDER LIGHTHOUSE APPARATUS.

Royal Institution,
3d December 1860.

I HAVE been engaged at Birmingham for three days (26th, 27th, 28th November) with Mr. James Chance, in ascertaining for each particular rib of such a panel as that referred to above, the best point or points in relation to the burner from which the rays should issue, that the maximum illumination might be at the horizon; and also testing by practice the method proposed by Mr. J. Chance of adjusting the ribs to each other and to the lamp, so that they should coincide in their action.

A fixed light lenticular panel consists of a chief broad middle band, and of other bands or ribs above and below it, forming two groups, generally nine in each. These, when associated in the panel frame, have, according to the accepted rule, their common focus at 28 mm. above the burner of the lamp.

The relation of the flame and burner to the upper and lower parts of the lenticular panel is the same in kind, though not in degree as their relation to the upper and lower reflectors. Thus, the opaque burner, which hides much of the flame from the lower reflectors, also hides flame from the lower part of the lenticular panel, though not in the same degree; but as the lenticular panel is a very chief part of the apparatus, any desirable correction which can be made amongst its parts, if possible, becomes of importance.

Using a flame such as that represented in the report of the 19th October 1860, in conjunction with a panel of the kind described, and casting the light passing through each rib separately in a perfectly horizontal direction, we found that the best focal point for the middle or chief rib was 20 mm. above the burner at the axis; that the upper ribs, though varying one from another, might have the same points of 20 mm. taken for their average or common focus; and that the lower ribs required much higher focal points in the axis, varying from about 18 to 30 mm. above the burner, all of which might be referred to a common focus, 11 mm. up and 36 mm. aside towards the panel.

Supposing that these numbers (or any other) were determined upon, then the possibility of adjusting the parts of the panel to each other came to be considered; without which possibility it would not be right for the authorities to require that a finished panel should be subject to examination by the focimeter, in relation to such given points. The ribs of a lenticular panel cannot be adjusted to each other by any rotation of them on a horizontal axis, as is the case with the ribs of a reflector panel, but only by elevation or depression in respect of each other; and now Mr. Chance proceeded to show me, how, by ascertaining the best focal point for each rib and their relation to the focal point of the great central rib, he ascertained how much they were in error; and then what proportion of glass would require to be removed from the broad bearing surface of this or that rib to bring the whole into nearest approximation to the desired position. This he carried into effect with the panel which we had had under examination, and which had been constructed in the ordinary way, and without any particular view to such a correction; and the consequence was that a panel was produced, which, when set up with the focimeter upon the burner at the numbers given above, and a small flame upon the distant (107 feet) dead level for each rib, gave a perfect practical result. The space between the green and red light was the part of the flame observed, and the error for any rib was not more than 1 mm. except in two cases out of nineteen, in which it did not exceed 2 mm. When the great lamp was lighted the effect was in accordance with the expected result. The coincidence of all the rays in one common maximum could only be observed at a great distance, i.e., at the dead level horizon; but each rib could be examined for itself and for the dead level of that rib.

It must be thoroughly understood that the focal numbers have relation to the flame of the great lamp. As before stated, the higher and more powerful the flame, the greater height should the focal distances be above the burner, but even with a very high flame we do not find that the focal point of the middle belt and upper ribs can be raised higher than 23 or 24 mm. above the burner, without sending the brightest light to the sky. The character and size of the flame differ very much at times, and even with the same flame persons differ very much in their estimate of its magnitude, and the place of its brightest part. We have taken a flame corresponding, as far as I can judge, with that figured in the report of the 19th October 1860. It is easy to obtain a higher flame by close attention and for a short time; but I do not think that a higher one is often sustained in lighthouses.

In respect of the "Smalls" light, therefore, I recommend a focal point for the central and upper ribs of the lenticular panel of 20 (or 21) mm. above the burner; and for the lower ribs a point 11 mm. up and 36 mm. aside in relation to the dead level, and a further correction of 3 mm. for the dip to the sea horizon.

The final examination of an optic apparatus for lighthouses can only be carried on, with the degree of accuracy which I have described, at the manufactory, or at a place arranged with all appliances for the purpose, or at the lighthouse (when in place) when there is a good clear sea horizon. In the case of the "Smalls" no difficulty will occur since the apparatus is already in the hands of Messrs. Chance.

Perhaps it may be agreeable to the Trinity House to be informed that the changes proposed now and formerly are all in accordance with observations made by the Astronomer Royal at Messrs. Chance's in the beginning of the year, and which he communicated to me personally in April last.

(Signed) M. FARADAY.

3d December 1860.

North Foreland Light,
27th August 1860.
To P. H. Berthon, Esq.
Sir,

I beg with great respect to make the following report upon the four-wick burner and pressure lamp now in use at this station :—

To the inquiries of committees at various visits as to the height at which the flame could be maintained, the lightkeepers have not been able to return a satisfactory answer, the flame never having reached the desired height, although still closely attended to. Still there were times at which the light burnt much better than others, and without perceptible cause. This led to a consideration of the draught *through the burner*.

Whereupon the cylinder was lowered a little more, and a small piece of piping placed so as to connect the pipe of the throttle valve with that immediately above, thereby imperfectly forming one continuous piece six feet four inches high, through which the draught ascends from the burner.

The effect of this was soon evident, the flame, under the control of the condensor or throttle valve, was continued at an average height of at least $3\frac{1}{2}$ inches, probably nearer 4 inches, with no tendency to smoke, consuming 3 pints more oil than on the previous night, and although necessarily requiring close attention, not that very anxious attention which it has heretofore. This was first tried on the night of the 22d, and continued up to the present time with the same result, although the trial is an imperfect one.

I have, &c.
(Signed) JAS. CHAPMAN.

EXTRACT of LETTER from Messrs. CHANCE, dated
6th December 1860.

"We beg to acknowledge your letter of the 5th instant with its enclosure, and to assure you that we shall at once proceed with the adjustment and construction of the apparatus for the Smalls Light, in conformity with Professor Faraday's recommendation and with your desire."

REPORT ON THE SMALLS APPARATUS.

Royal Institution,
30th January, 1861.
Sir,

I WENT on Monday last to the manufactory of Messrs. Chance at Birmingham, to examine the optical apparatus for the Smalls Light. You are aware that in consequence of certain careful and prolonged experimental inquiries, adjustments altogether new, both as to their amount and their nature, have

been determined upon, and put into practice for the first time in this apparatus.

The manufacturer was instructed to adjust the various glass pieces by the following foci, the distances given being the foci distances above the burner and aside from its axis :—

	m.m.	m.m.
Upper reflector bands	- 28 up and 20 aside.	
Lower " "	- 25 up and 40 aside.	
Lenticular refracting panel—		
Central zone and the upper ribs	- 21 up and 0 aside.	
The lower ribs	- 11 up and 36 aside.	

all these adjustments being to the *sea horizon*.

The apparatus has been put together by Mr. James Chance with these adjustments, and being in a proper place, I had the focimeter set upon the burner and a true *sea horizon* mark placed in the distance.

The whole was so true that the ray proceeding to the eye through the middle of each piece of glass passed by the focimeter at the point desired. The greatest departure was but 2 m.m., and very few of these occurred. Further, the manner in which, as the apparatus revolved or the eye was moved about, the object at the horizon passed laterally from one panel to another, or vertically from one rib to another, showed the perfection of the adjustment of each individual piece by the harmony and consistency of the whole, though there were above 300 pieces of glass associated together.

At night the lamp was lighted and observed from the distance ; the results accorded perfectly with the anticipations. As the head was raised or lowered each piece of glass showed its maximum effect at the right place, its light coming in or going out as it should do in relation to the distant horizon ; and I think that, as far as regards the system of adjustment, the power of carrying it into effect, and finally of examining its correct application, everything is proved to be practicable, and has here been realised. The essential points now are to supply a good lamp, and to provide that it be kept in good order.

In relation to colour and striae the glass was very good.

Captain Bayly and Captain Nisbet were present at the examination.

It is to be remembered that the adjustments made are all in reference to the large flame of a lamp having four cottons, the utmost advantage having been taken of such portions of the flame as were visible in different directions. These adjustments would not be the most perfect for a concentrated light, such as the magneto-electric discharge.

I am, &c.
(Signed) M. FARADAY.
P. H. Berthon, &c., &c.,
Trinity House.

OBSERVATIONS BY MR. JAMES CHANCE.

Glass Works, near Birmingham,
26th January, 1861.

SIR, I RECEIVED a letter from you last November, in which you intimated that I might make additions to the answers, which I had already sent, to certain questions issued by the Commission for Lights, &c.

I have been too much engaged to avail myself sooner of this opportunity, but I now enclose some observations concerning the subject to which those questions refer, and also a table, with the general theorem for its calculation, in relation to question No. 3.

This table, as you are aware, has been prepared in accordance with the suggestions of Captain Ryder, one of the Commissioners.

I am, &c.

JAMES T. CHANCE.

J. F. Campbell, Esq.,
Secretary to the Royal
Commission for Lights, &c.

In April last I replied to some printed questions issued by the Royal Commission for Lights, Buoys, and Beacons, in reference to the desirability of certain data being communicated to the manufacturer of dioptric illuminating apparatus for Lighthouses, upon his receiving an order.

The attention, which subsequent opportunities have enabled me to give to the subject of that kind of apparatus, has convinced me of the great practical importance of the suggestions implied in those questions.

At that time I assumed that the respective foci of the dioptric and catadioptric portions, corresponding to rays emerging in the * level direction, had been placed in the best positions in relation to the flame, and to the wick-holder (or "burner") of the lamp; and that the only question which depended upon the elevation of the apparatus was, whether or not those foci should by adjustment be made to become in all or some cases the sea-horizon foci.

The sanction of long usage, combined with the highest scientific authority in the first instance, justified me in making that assumption.

No one, however, could inspect an apparatus adjusted according to the received focal arrangements, in relation to the lamp, without being struck with the large proportion of light which was thrown above the level direction, and still more so above the sea-horizon direction, not only by the two catadioptric portions of the light, but even by the dioptric one. But, in explanation of this apparent waste of illumination, it was urged that the customary focal adjustments, although they might cause the diversion of so much light upwards, were the best ones for transmitting the beams from the most effective sections of the flame in the direction of the sea horizon; and that it was not even necessary to make an allowance for the dip of the horizon.

In the spring of last year the Chairman of the Royal Commission put me into communication with the Astronomer Royal, who on two occasions at that time visited these works in reference to the questions raised by the Commissioners concerning dioptric sea-lights. On one of these visits Professor Airy examined the directions of the most effective beams of light proceeding from the different parts respectively of a first order fixed apparatus, whose focal adjustments in relation to the lamp were for the most part in accordance with the recognized system; and for that purpose he employed a series of posts placed at

various distances from the apparatus, and having the level direction indicated upon them.

The observations of Professor Airy on that occasion, combined with subsequent experiments, which I was *thereby* induced to make, rendered me sceptical as to the existing system of adjustments for the larger kind of dioptric lights; and, shortly afterwards, in the construction of some first order apparatus for the Russian Government, besides allowing for the dip of the horizon, I departed considerably from the accustomed rules, so far as it concerned the positions of the sea-horizon foci of the upper and lower series of the totally reflecting zones. The chief change was made in the adjustment of the *lower* reflectors, by raising from 10mm. to 12mm. higher above the burner, than what had been previously done, the place of intersection of the axes of the pencils of light transmitted by the successive zones respectively to the sea-horizon. This change, while it seemed to benefit decidedly the distant sea, transferred from the sky to the sea an important angle of vertical divergence of very effective illumination. Since that time, Professor Faraday, on behalf of the Trinity Board, arranged a most complete set of experiments at Whitby, which, as the Commissioners are aware, impressed upon the minds of those who witnessed them a conviction that the old system of adjusting the upper reflectors, no less than the lower ones, admitted of considerable modifications.

Professor Faraday and myself have subsequently been making some experiments upon the adjustment of the *refracting* portions of the fixed dioptric apparatus; and, although it would scarcely be suitable for me to enter here upon the details of those experiments, I may safely assert that they have unquestionably raised doubts concerning the received focal adjustments of the refractors in relation to the burner. Those experiments, indeed, quite confirm the observations made by the Astronomer Royal when he inspected last spring at these works, on the occasion already referred to, a first order fixed apparatus.

The primary problem, then, is, to determine the best positions in the flame of the sea horizon foci of the refracting portion, and of the two reflecting portions, respectively, of the apparatus; and whether these positions are to be constant for all elevations of the lantern, and for all the peculiarities of different localities; or whether in any one of the three portions above named the adjustment of the sea horizon foci in relation to the lamp should be adapted specially to the elevation of the light and to the peculiar requirements of the place which has to be lighted.

I use the term *sea horizon* foci, because I take for granted that every portion of the apparatus should, in *all cases*, be adjusted in reference to the sea horizon direction and not the level direction. For the refractors and the lower reflectors it is quite essential, as I am about to show, to make the adjustments with reference to the sea horizon; and inasmuch as there is no practical difficulty whatever in causing rays of light from any given points in the flame to emerge from the apparatus in the direction of the sea horizon quite as accurately as in any other direction; therefore, apart from any real advantages to be gained by thus taking the dip of the horizon into account, the omission of that correction implies an inexpedient disregard of accuracy of adjustment generally. It should also be borne in mind that any error in arriving at the level direction is as likely to send the light still *more above* the sea horizon direction as to bring it downwards.

The first questions which the manufacturer would wish to have answered, before proceeding with any adjustments, would be, what are the special require-

* The word "level" is used to signify the *horizontal* direction; that is, the direction which is at right angles to the vertical axis of the apparatus.

ments of the particular locality? Is it desired to send the most effective beams of light to the furthest distance, although the mariner might thereby be deprived of the advantage of light as he approached shore? Or is it necessary to illuminate the sea up to a moderate distance from the Lighthouse, notwithstanding that this provision might slightly diminish the intensity of illumination at and beyond the horizon? Or, in the case of a fixed light, is its intended site to be such, that, within certain points of the compass, the furthest range of visibility must be chiefly provided for; while within other angles of the horizontal are to be lighted the part of the sea near to shore should have its share of illumination?

Let us then consider whether any portion of a dioptric and catadioptric apparatus could have its adjustments accommodated to the particular circumstances of its intended destination. For this purpose it will be convenient to refer separately to each of the three component parts of a complete light, namely, the lower reflectors, the middle belt of refractors, and the upper reflectors.

I. Lower Reflectors. The position of these zones in relation to the burner, which intercepts from them a large portion of the flame, confines their vertical divergence within so narrow a range, that if they were adjusted with reference to the illumination of the sea near to shore, the sea-horizon would, in all cases except those of a low elevation, receive either no light at all, or only a very faint one. The best use, therefore, which can be made of the lower reflectors is, to transmit to the sea-horizon the light from the most brilliant parts of the flame, which correspond with the respective zones. These parts lie within narrow limits, which evidently change their position according to the height of the flame. The only practical way is, to choose such a height of flame as is likely to be actually maintained, and then to place the sea-horizon foci at the greatest distances above the burner which are compatible with the most effective illumination of the sea-horizon by each of the reflectors respectively.

The choice of these foci may vary slightly with the differences of optical judgment of different persons; but whatever positions of the foci may be determined upon, it is evident that all adjustments of these lower reflectors must be made to the sea-horizon direction.

II. The Refractors.—The main point, especially in the case of a fixed light is, to determine the brightest sections of the flame corresponding with the middle belt, and all the other refracting bands above and below respectively; and then so to adjust these various refracting parts in relation to the burner that their respective sea-horizon foci shall be placed in the corresponding brightest sections of the flame. These focal positions can only be obtained by experiment, and they will vary with the height of the flame and the optical judgment of the observer; but the limits of variation are confined within the height of only a few millimetres. One thing, however, is quite certain, that the sea-horizon foci must not be placed below the corresponding brightest parts of the flame, for the sake of increasing the vertical divergence below the sea-horizon direction, for that increment would be very small, whereas the loss of light at the horizon would be considerable.

The importance of accuracy of adjustment to the sea-horizon, both of the refractors and of the lower reflectors, is enhanced by the consideration that the same parts of the flame, within a narrow range (not exceeding one quarter of an inch even for a high elevation, such as that of 500 feet), which illuminate the sea-horizon, also illuminate about *three-fourths* of the whole distance from the sea-horizon to the base of the tower.

In reference to this important consideration, it may be useful to remark that an angle of vertical divergence equal to one-fourth of the dip of the horizon illuminates one-half of the whole distance from the horizon to the tower; and that an angle of

vertical divergence equal to the dip of the horizon, illuminates nearly three-fourths of that distance (accurately 0.732). To show, on the other hand, how little is gained by increased vertical divergence at the sacrifice of brilliancy at the horizon, it may be added that an angle of vertical divergence, also equal to the dip of the horizon, illuminates only a small fraction of a mile as we approach within one or two miles or so from the tower.

III. Upper Reflectors.—It is in this portion of a dioptric apparatus, and generally in this only, that it is feasible to provide for the illumination of the sea towards land, by a corresponding adjustment of the sea-horizon foci, without any serious diminution of the light received by the distant sea. This circumstance arises from the relative positions of the flame and of the reflecting zones, by which there is a considerable range due to the breadth of the flame, for illuminating the sea-horizon effectively, and yet for providing a large angle of vertical divergence below the sea-horizon direction.

Undoubtedly there are certain oblique sections of the flame which would produce, through the respective reflecting zones, the maximum intensity of illumination in the direction of the horizon; and in cases where the distant sea *alone* has to be provided for, the sea-horizon foci of the upper reflectors should be placed in those sections respectively.

Generally, however, a slight diminution of light at the horizon will be admissible for the sake of illuminating the parts of the sea near to the tower, and in such cases the positions of the sea-horizon foci in relation to the burner must depend in some degree on the intended *elevation* of the apparatus above the sea. Suppose, for example, that light were required up to one nautical mile in each of the two instances of elevations of 150 feet and 250 feet respectively. The requisite angle of vertical divergence from the sea-horizon direction downwards would in the former case be $1^{\circ} 13' 15''$, whereas in the latter one it would be $2^{\circ} 6' 15''$, that is, $53'$ larger.

There is of course a limit to this angle of vertical divergence, and accordingly, for high elevations we must be content with the light not approaching so near to the tower, the distance from the tower up to which the sea can be illuminated being *nearly* proportional to the height of the tower for a given size of apparatus.

I append a table which may be useful in determining the best positions of the sea-horizon foci of the upper reflectors for any particular situation and elevation.

This table was framed according to the suggestions of Captain Alfred Ryder, R.N., one of the Royal Commissioners, and is extremely convenient for exhibiting, in addition to the other information which it affords, the heights in the axis of the flame which sub tend at the middle of the refractors certain angles of vertical divergence.

I have added the general expressions which connect the angle of visible dip of any point on the sea for a given height of tower with the distance of that point from the Lighthouse, in order that the accompanying table may be extended as it may be required.

In regard to the adaptation of the upper reflectors in any degree to the illumination of the sea near to the tower, it may be argued that such a height of the flame ought always to be maintained as will effect that purpose through the medium of the *refractors*. With that reasoning I entirely concur, but still the flame will be sometimes allowed to become somewhat low, and the mariner, on approaching land, might consequently be deprived of the customary beacon. Now the great advantage afforded by the upper reflectors is that the parts of the sea near to land are illuminated by them, *even when the flame is low*, so that they serve to compensate for the non-effectiveness of the refractors when the flame is low, as well as to increase their effectiveness when the flame is high.

It may be said that the accuracy of adjustment which is implied in the foregoing remarks is not

generally practicable. There is, however, a plan of proceeding which removes all difficulties. Before a single piece of glass is adjusted in its place, the whole of the metallic framework should be fitted together just as it will be at its final destination, and the glass must be adjusted *while the framework is in that state of ultimate completeness*. Every part of the apparatus may then be adjusted to the sea-horizon direction just as accurately as if the glass were being placed in the frames at the Lighthouse itself, with a *well defined sea-horizon* for the object, which, however, is not in this climate of frequent occurrence.

I doubt, indeed, very much, whether such accuracy of adjustment would have been practicable in the ordinary course of manufacture, had it not been for the employment of that internal method of inspecting the direction of light proceeding from an external object, which was pursued by the Commissioners and by the Astronomer Royal in the examination of various Lighthouses during last year, and which I have found to be almost indispensable in determining the most advantageous positions of the sea-horizon foci of the refractors and reflectors.

A first order fixed apparatus, which has just been completed at these works for the Trinity House, being intended for the Smalls Lighthouse, was in course of construction last summer, but, by the direction of the Elder Brethren, the final adjustments of this apparatus were expressly delayed until December last, for the purpose of adopting all the latest modifications which might seem desirable, in consequence of the various experiments made both here and at Whitby by Professor Faraday, to which I have alluded. This apparatus, accordingly, includes the innovations of adjustment to which I have referred in the foregoing observations.

While, therefore, I have now been making additional remarks in reply to the first three questions of the Commissioners, my former answer to the fourth question is not applicable to *present* circumstances.

JAMES T. CHANCE.

To find the equation between the distance from the Tower of any point on the sea and the angle of its visible dip :

Let C be the light on the tower CE ;

E P Q the sea ;

C T the direction of a ray of light without refraction ;

C M P its actual path ;

C N and P M are horizontal ;

N P and C M are vertical ;

N C T is the visible dip at C of the point P ;

Join C P ;

Let r = radius of curvature of the sea at E ;

N C T = δ CE = h CN = x N P = y ;

$y = x \tan \delta + T P$;

and as T C P is very small,

$$T P = T C P \cdot \frac{x}{\cos^2 \delta} = \frac{0.08}{r} \cdot \frac{x^2}{\cos^2 \delta}$$

because T C P may be taken = $0.08 \frac{x}{r}$ (see Note)

$$\therefore T P = (0.08 + 0.08 \tan^2 \delta) \frac{x^2}{r} = 0.08 \frac{x^2}{r} \text{ approximately}$$

for such values of δ as occur in practical questions ;

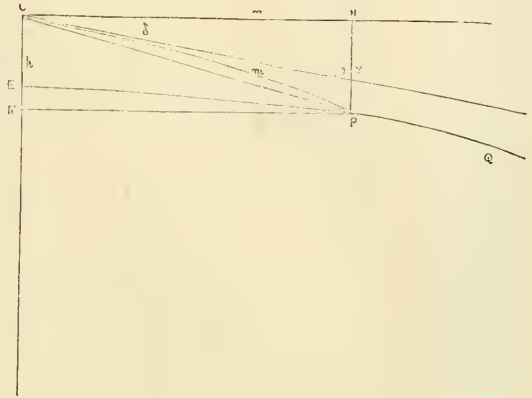
$$\text{hence } y = x \tan \delta + 0.08 \frac{x^2}{r}$$

$$\text{also } y = C E + E M = h + \frac{x^2}{2r}$$

$$\text{therefore } x^2 - \frac{2r}{0.84} x \tan \delta + \frac{2rh}{0.84} = 0$$

$$x = \frac{r \tan \delta}{0.84} \left(1 + \sqrt{1 - \frac{2h \cdot 0.84}{r \cdot \tan^2 \delta}} \right)$$

(the positive sign is not required).



At the sea-horizon, where both values of x are equal,

$$1 - \frac{2h}{r} \cdot \frac{0.84}{\tan^2 \delta} = 0.$$

Let Δ = visible dip of the sea-horizon

D = distance of the sea-horizon from the tower

$$\text{Then } \tan \Delta = \sqrt{\frac{2h \cdot 0.84}{r}}$$

$$\text{and } D = \frac{r \tan \Delta}{0.84} = \sqrt{\frac{2rh}{0.84}}$$

$$x = \frac{r \tan \Delta}{0.84} \left(1 - \sqrt{1 - \left(\frac{\tan \Delta}{\tan \delta} \right)^2} \right)$$

$$\text{Let } \frac{\tan \Delta}{\tan \delta} = \sin \theta$$

$$x = \frac{r}{0.42} \tan \delta \cdot \sin^2 \frac{\theta}{2} \text{ for finding } x \text{ from } \delta$$

$$\text{and } \tan \delta = \frac{1}{x} \left(h + \frac{x^2}{r} \cdot 0.42 \right) \text{ for finding } \delta \text{ from } x.$$

If δ be small,

$$x = \frac{r \delta}{0.84} \left(1 - \sqrt{1 - \frac{\Delta^2}{\delta^2}} \right)$$

$$\text{Let } \delta = \frac{5\Delta}{4}, \text{ then } x = \frac{D}{2}, \text{ that is, one half of the}$$

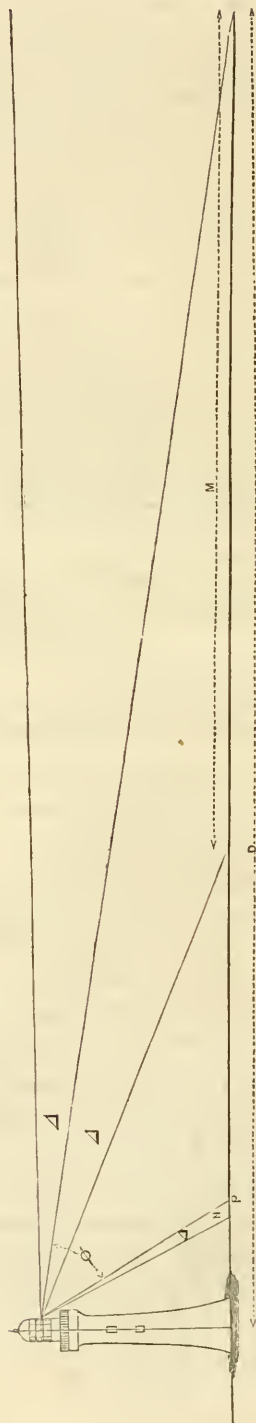
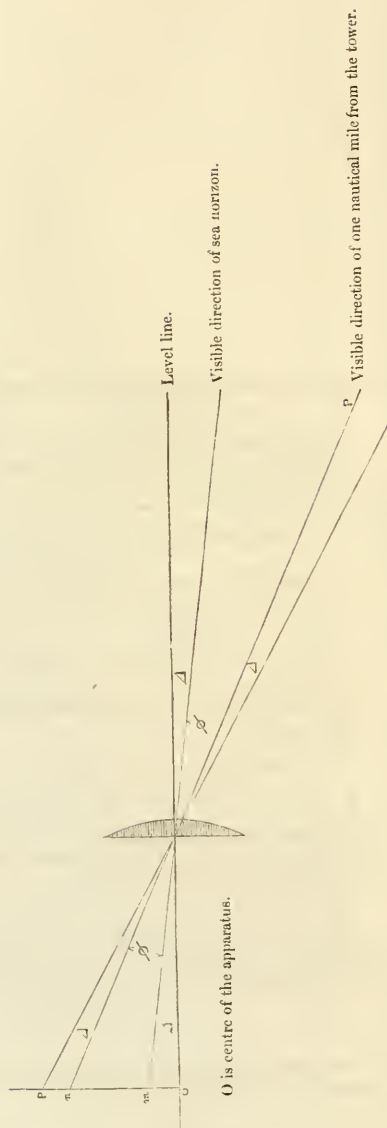
whole distance from the sea-horizon to the tower is illuminated by an angle of vertical divergence equal to $\frac{1}{4}$ th of the visible dip of the horizon.

$$\text{Again, let } \delta = 2\Delta, \text{ then } x = 2D \left(1 - \sqrt{\frac{1}{4}} \right)$$

$\therefore D - x = 0.73205 \times D$, that is, nearly three-fourths of the whole distance from the sea-horizon to the tower is illuminated by an angle of vertical divergence equal to the visible dip of the horizon.

JAMES T. CHANCE.

Note.—I am indebted to the Astronomer Royal for information as to the correction for refraction.



Note.

With reference to the diagram
which reaches the paper sent in
by Mrs. Chance on the 24th of Aug
1861. —

- 1 See my private papers relative to claims
inventions in which this principle
appears continually. — since. 1857
- 2 Published paper in Liverpool Ph
journal. April. 1858
in which the principle is twice to
use. —
- 3 Paper in ~~Liverpool~~ Photographic
journal Vol. V P. 83. Nov 1858
See mss. diagrams made before the
paper was read and now pasted in
to my copy of the journal. —
In this the whole argument rests
upon the principle of the Daguerren
which reveals our Church's papers.

4. Paper on Sun Dial. which is constructed on the principle of the Diagram. - published. in -

Copies of this paper were given to the Commissioners and the Dial itself has been in the board room ever since the meeting began. -

1859.

5. See Mr Chance's reply to the Scientific questions printed.

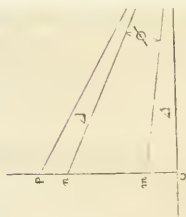
6. See note in the Minute book

as to first visit to Birmingham.

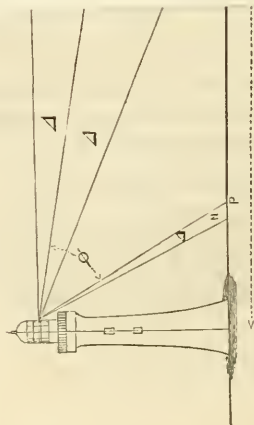
7. See notes by me ^{from which papers relating to Mr Chance even distinctly were given out by me} in the paper the ^{was printed} Appendix paper and drawing & Photographs in numbers.

8. See in particular visit to Guisnes & South Foreland

9. See drawing made by me on our return Capt Ryder's drawing and his calculations made at my request.



O is centre of the apparatus



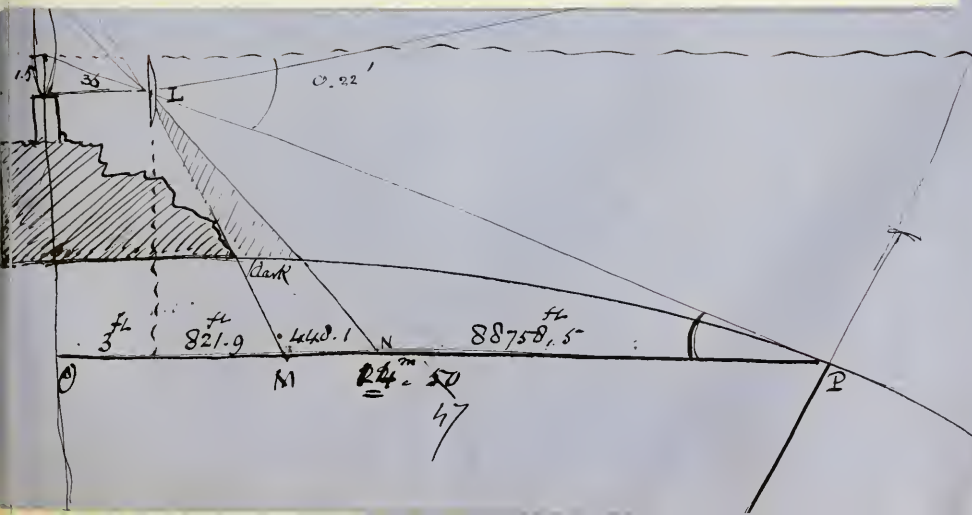
- to See my diagram produced in
the train going to North Lavenham
with pencil marks thereon made
by Chance. Stevens &c. See my
Photographic camera with circular lens
11. In Correspondence with the author

11. In Correspondence with the Astronomer

Royal Menecement which was
shown to Mrs Chance & to Mrs
Stevenson at Whitey. - Don

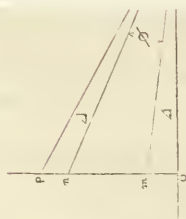
which. These gentlemen acknowledged
for the first time that my diagram
was right - ~~but~~ One of them
Mr. James Chance voluntarily
offered to apologise for having
treated the diagram as if it
were ridiculously wrong on the
journey to South America.

12. On referring to these it will be
conceded that the claims made by me
in my letter of the 1st is not to be

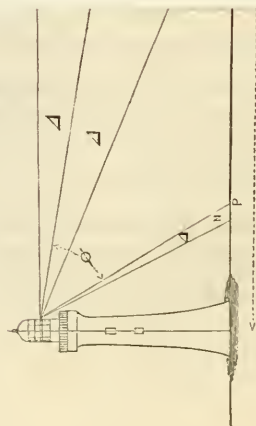


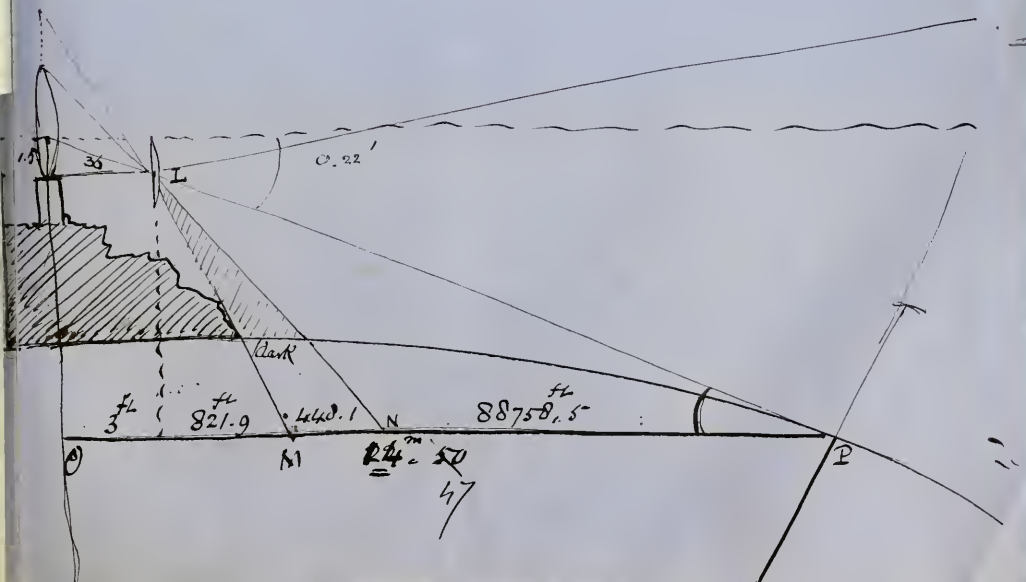
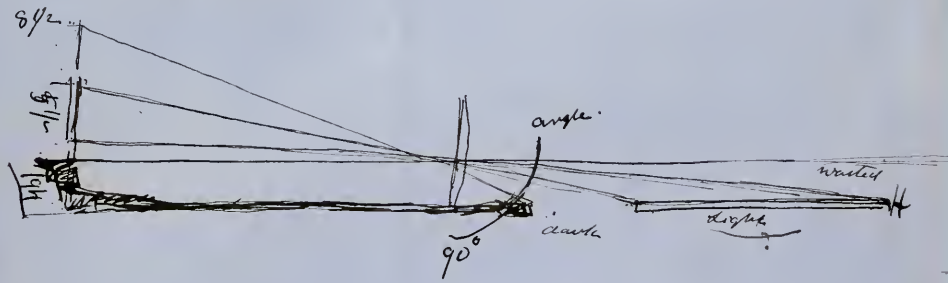
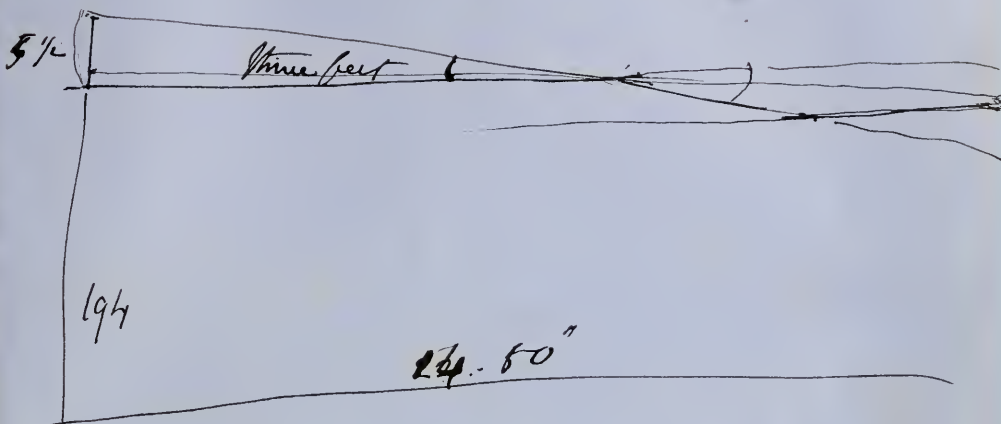
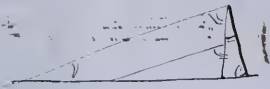
unless my diagram had appeared
 without acknowledgement at the
 head of Mr. Chene's paper. I
 should never have imagined
 that my claim could possibly have
 been in doubt for a moment
 but as it has so appeared.
 this is written for
 use of necessity. —

I wrote for the Commissioners
 not for individuals, and
 in particular not for Gentlemen
 who are not on the Commission
 at all.



O is centre of the apparatus



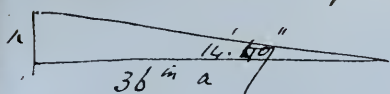


Capt^m Ryder

I wish to meet
12. to meet Grace

who has telegraph
to the ad^r & to
that he is coming
FR ✓

To find true position of base of flame



$$\frac{a}{a} = \tan 14.47^\circ$$

$$h = a \tan 14.47^\circ$$

$$\log h = \log a + \log \tan 14.47^\circ - 10$$

$$1.556302$$

$$7.609857$$

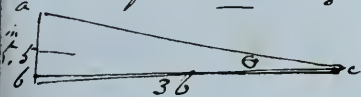
$$30912$$

$$9.197071$$

$$.01574$$

The base of the flame should be .01574 of an inch above the plane of the center of the lens.

To find divergence



abc is rec'd a rt. L.

$$\text{therefore } \frac{5.5}{36} = \tan L_c$$

$$\log 5.5 - \log 36 = \log \tan \theta - 10$$

$$0.740363$$

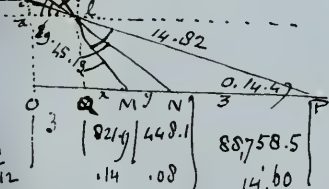
$$1.556302$$

$$9.184061$$

$$\text{Div. } 8.41'$$

To find PN, MN, OM.

When the flame is removed adjusted - so low as that the horizon cuts the flame 1.5 inches above its base



$$60 : 49939 :: 47$$

$$3495883$$

$$199756$$

$$60/23471 \quad 3.3(309119)$$

$$10$$

$$5.47$$

$$540$$

$$71$$

$$60$$

$$113$$

$$80$$

$$533$$

$$60 : 100 :: 49$$

$$6 : 10$$

$$3 : 5$$

$$49$$

$$265$$

$$82$$

To find Ls.

$$\log \tan \theta_1 = \frac{1.5}{36}$$

$$0.176091$$

$$1.556302 \quad 2.23.1$$

$$\log \tan \theta_2 = \frac{5.5}{36}$$

$$0.740363$$

$$1.556302 \quad 8.41$$

$$\log \tan \theta_3 = \frac{8.5}{36}$$

$$0.929419$$

$$1.556302 \quad 13.17$$

$$L_{dlc} = 2.23 \quad 6.18$$

$$dlb = 8.41 \quad 4.76$$

$$dla = 13.17$$

$$dla - dlc = cla = 13.17 - 2.23$$

$$= 10.54$$

$$= MLP$$

$$QLP = 90 - 13.17 = 76.43$$

$$QLM = 76.43 - 10.54$$

$$= 65.89$$

$$76.43 \quad 2.207802$$

$$x = a \tan 65.89 \quad \log \tan 65.89$$

$$a = 194 \quad 821.9 \quad 12.714730$$

$$y = \left\{ \frac{QN - 11}{a} \tan QLN 81.19 - x \right\} \tan 81.19$$

$$\log y = 8.194 \quad 2.207802$$

$$\tan 81.19 \quad 10.816093$$

$$\text{subn } 13.103095$$

$$1270.$$

$$821.9$$

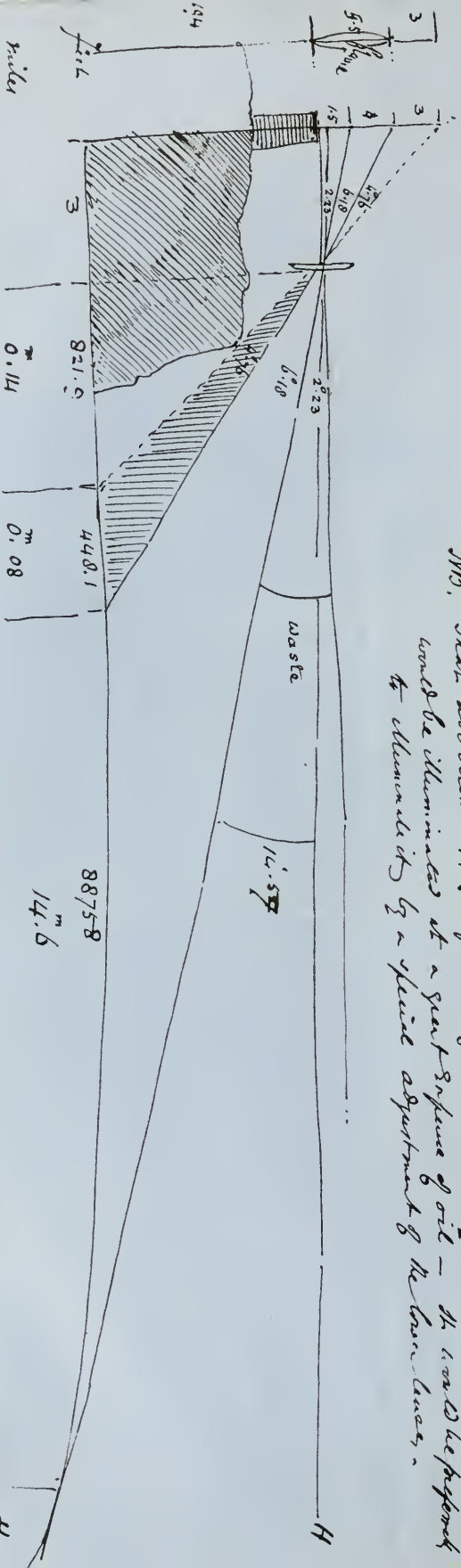
$$440.1$$

$$\begin{array}{r} 82 \\ 25 \\ 10 \\ 74 \end{array} \quad \begin{array}{r} 74 \\ 10374 \\ 8892 \end{array} \quad \begin{array}{r} 8003150 \\ 9003150 \\ 1273 \\ 88958.5 \end{array}$$





Cape Girardeau



(2) The divergence of a 5" flame with a 36" and opening the is 8° 41'

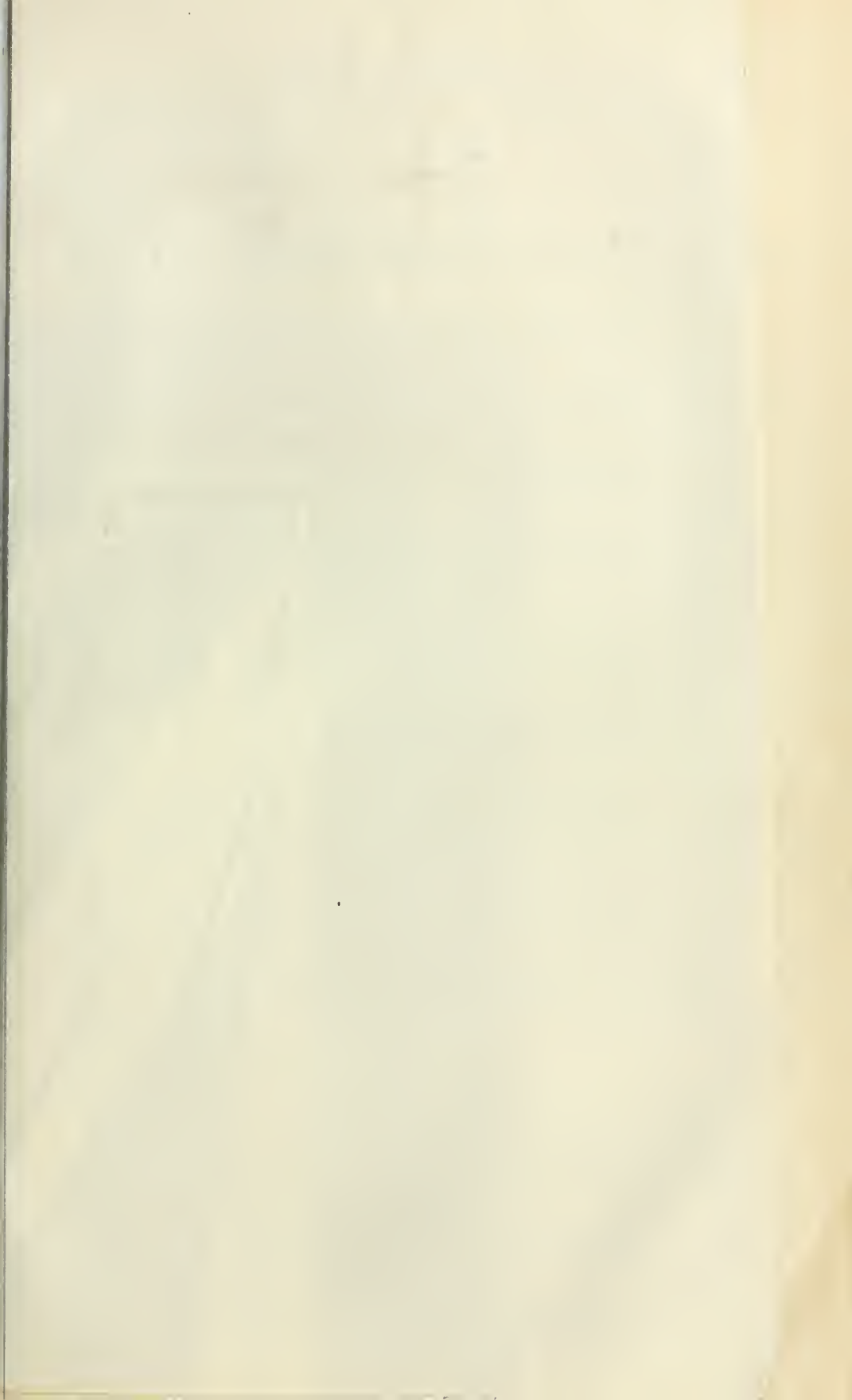
(3) In this case the tower 1.5" is erected

We sent 4" illuminating 14.6 from the horizon being 1273 feet dark -

We sent 3" of the flames was raised that much and only 200, to the flame illuminating 14.6 from the horizon being 1273 feet dark -

Ms. That additional 44825 feet, not attainable by adding 3" to the flames would be illuminated at a great expense of oil - the tower would be projected to illuminate it by a special adjustment of the tower flames.

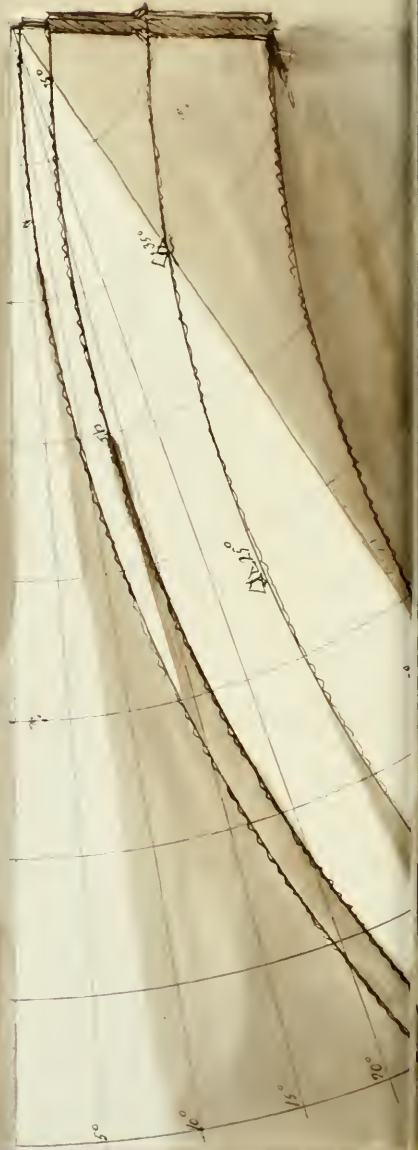
90031 feet = 14.82 miles



90031 feet = 14.82 miles

March. 61.

To show that which is
shown already in by
paper that the 2.
kilometres lost at the
horizon is not the
only by 3.



In this TABLE MILES are NAUTICAL, and a Nautical Mile is taken equal to 6082' 123 feet, that is, the radius of curvature of the sea is assumed as 3960 BRITISH STATUTE MILES.

Height above the sea of the centre of the apparatus.	Distance from the tower of the sea horizon D.	Vertical angles between the visible directions of the sea-horizon, and of the following points respectively on the sea.						M. Distance from the sea-horizon inwards illu- minated by a vertical angle = Δ .	N. Distance from the point P. inwards illu- minated by a vertical angle = Δ .	Heights of the flame at the axis of a first order dioptric apparatus (radius = 92 centimetres), subtending the following angles respectively.				
		Quarter of a mile from the tower.	Half of a mile from the tower.	Three quarters of a mile from the tower.	Point P, one mile from the tower.	Two miles from the tower.	Visible dip of the sea-horizon. $\alpha, m.$			Angle ϕ between visible directions of sea-horizon and one mile spot P. $m, n.$		Angle = Δ below one mile spot P. $n, p.$		
							Millimetres.			Inches.	Millimetres.		Inches.	
Feet.	Miles.	° ' "	° ' "	° ' "	° ' "	° ' "	° ' "	Yards.	Millimetres.	Inches.	Millimetres.	Inches.	Millimetres.	Inches.
60	8.986	2 8 8	1 0 29	0 37 59	0 26 47	0 10 15	6.578	372	2.020	.079	7.168	.283		
70	9.706	2 30 6	1 11 11	0 44 55	0 31 50	0 12 38	7.105	349	2.182	.086	8.318	.335		
80	10.376	2 52 6	1 21 54	0 51 53	0 36 55	0 14 44	7.596	330	2.352	.092	9.881	.389		
90	11.005	3 14 6	1 32 40	0 58 53	0 42 2	0 17 1	8.056	314	2.468	.097	11.252	.443		
100	11.601	3 36 7	1 43 28	1 5 55	0 47 11	0 19 21	8.492	300	2.708	.103	12.630	.497		
110	12.167	3 58 9	1 54 17	1 12 59	0 52 22	0 21 43	8.907	288	2.735	.108	14.016	.551		
120	12.708	4 20 11	2 5 8	1 20 4	0 57 34	0 24 5	9.303	277	2.827	.112	15.406	.607		
130	13.227	4 42 11	2 15 58	1 27 9	1 2 46	0 28 28	9.683	268	2.857	.117	16.803	.662		
140	13.726	5 4 12	2 26 50	1 34 15	1 8 0	0 29 52	10.048	259	3.086	.121	18.203	.717		
150	14.208	5 12 13	2 48 35	1 41 23	1 13 15	0 31 18	10.400	251	3.194	.126	19.607	.772		
160	14.674	5 26 13	3 10 59	1 48 31	1 18 30	0 32 44	10.741	244	3.299	.130	21.015	.827		
170	15.125	-	3 23 58	1 55 40	1 23 47	0 34 13	11.072	238	3.400	.134	22.427	.883		
180	15.564	-	3 36 58	2 2 46	1 29 4	0 35 38	11.393	232	3.499	.138	23.840	.938		
190	15.990	-	3 49 58	2 10 11	1 35 39	0 37 5	11.705	226	3.595	.141	25.257	.995		
200	16.406	-	3 32 19	2 17 11	1 39 39	0 39 35	12.009	221	3.688	.145	26.677	1.050		
210	16.811	-	3 43 7	2 24 21	1 44 27	0 41 16	12.306	216	3.779	.149	28.098	1.106		
220	17.206	-	3 54 1	2 31 32	1 50 16	0 43 3	12.596	212	3.868	.152	29.522	1.163		
230	17.593	-	4 4 56	2 38 43	1 55 34	0 45 33	12.879	208	3.955	.156	30.947	1.218		
240	17.971	-	4 15 51	2 45 55	2 5 14	0 47 50	13.156	204	4.040	.159	32.375	1.275		
250	18.342	-	4 26 47	2 53 8	2 6 54	0 50 17	13.427	200	4.123	.162	33.805	1.331		
260	18.705	-	4 37 42	3 0 20	2 11 34	0 52 34	13.693	197	4.205	.165	35.235	1.388		
270	19.062	-	4 48 37	3 7 32	2 16 55	1 1 7	13.954	193	4.285	.169	36.668	1.443		
280	19.411	-	4 59 33	3 14 46	2 22 16	1 3 39	14.210	190	4.364	.172	38.102	1.500		
290	19.755	-	5 10 27	3 21 58	2 27 36	1 6 11	14.461	187	4.441	.175	39.537	1.556		
300	20.093	-	5 21 22	3 29 12	2 32 58	1 8 43	14.708	184	4.517	.178	40.974	1.613		
325	20.913	-	-	3 47 16	2 37 16	1 15 6	15.309	178	4.701	.185	44.371	1.755		
350	21.703	-	-	4 5 20	2 59 49	1 21 30	15.887	172	4.879	.192	48.175	1.897		
375	22.464	-	-	4 23 25	3 13 14	1 27 55	16.445	167	5.050	.199	51.786	2.039		
400	23.201	-	-	4 51 30	3 26 42	1 34 22	16.984	162	5.216	.205	55.401	2.181		
450	24.608	-	-	5 17 41	3 43 38	1 47 17	18.014	153	5.532	.218	62.648	2.466		
500	25.939	-	-	5 53 51	4 20 36	2 0 17	18.989	146	5.831	.229	69.912	2.753		

The above letters refer to the diagram.

Generally,
 $M = D \times 0.73205.$

- (1). n, p may be taken equal to α, m for any practical accuracy, as it is evident by the few values given for n, p .
(2). For other orders of dioptric apparatus the values of α, m and m, n are proportional to the radii of the different sizes of apparatus.

The following Report was sent by the Commissioners of Northern Lighthouses on 5th February 1861:—

REPORT to Commissioners of Northern Lighthouses on Experiments on Lighthouse Flames, by Messrs. D. and T. Stevenson, Engineers to the Board.

IN consequence of the result of the experiments on lighthouse flames, which were instituted at Birmingham by Mr. Chance, and at which Mr. Thomas Stevenson, by request of the Royal Commission, was present, we intimated, on 10th December, our wish to repeat the experiments which were made by us at Edinburgh in July last. These showed that with the lamp 28^{mm} below the horizontal axis, the larger portion of the light was thrown below the axial line, a result different from what had previously been ascertained at Birmingham. It was therefore desirable that the Edinburgh experiments should be verified, and we were accordingly authorized by the Commissioners to do so.

After being very much retarded by the occurrence of unfavourable weather, we have at length succeeded in getting suitable nights for experimenting. Instead of again using the annular lens, which was the instrument employed in our former observations, we thought it better to use the cylindric refractor as that instrument had been selected for trial by Mr. Chance, and in this way the Birmingham and Edinburgh experiments are rendered comparable, the same kind of instrument having been used on both occasions.

The result of the experiments just completed has been a verification of those made with the annular lens. The following conclusions are deducible from the four diagrams which accompany this Report, and which represent observations that were made with the burner placed at the French standard height of 28^{mm} below the centre of the refractor:—

1st, The most powerful portion of the luminous beam in three of the series of experiments dips 0° 30' below the principal axis or earth's tangent, and in one of them about 0° 47'.

2nd, A large portion of the luminous beam is very nearly of equal power. The whole of this portion also dips below the axis.

3rd, Above the axial line the light loses power somewhat suddenly.

When the flame is of the standard height and form used in the Northern Lighthouses it does not therefore appear to be necessary, even in the highest dioptric station in Scotland, to raise the burner above the standard height in order to throw the beam of strongest light upon the horizon; the strongest light being in all cases (assuming the arrangement to be correct) already fully below the horizon, for the level of the intensest section of the flame averages in these experiments about $\frac{2}{3}$ of an inch above the French standard.

We have furnished the Royal Commission with a copy of the photograph of the Northern Lighthouse flame, so that they will be able to compare it with the one used at Birmingham, which being considerably smaller may account for the difference between the results of the Birmingham and Edinburgh experiments. (Signed) D. and T. STEVENSON.

Edinburgh, 5th February 1861.

NOTE to their Report of 5th February 1861, on the Experiments on Lighthouse Flames, by Messrs. D. and T. Stevenson, Engineers to the Northern Lighthouse Board.

THE experiments referred to in the foregoing Report were made at Arthur's Seat, Edinburgh. The lighting apparatus was placed in a lantern glazed with plate glass, the instrument employed being a first-class cylindric refractor, and a four-wick mechanical lamp similar in all respects to those used in the Northern Lighthouses. The place where the observations were made was the steeply sloping face of Salisbury crags, distant about 440 yards from the experimental light-room. The observations were repeated on several evenings with nearly similar results. Those shown in the diagram were the last made, and from greater precision having been attained in the arrangements, are regarded as in every respect the most accurate. The positions in reference to the lens

and burner of the different stations on the sloping face of Salisbury crags were marked by pegs, and ascertained in different ways, all of which gave very nearly the same results. The methods adopted were the measurement of the vertical angles by the theodolite, the ascertainment of the level of each peg by means of the spirit level; and lastly, these results were tested very accurately in the following manner:—The heights above the burner, of the images of the pegs, were carefully ascertained in the lightroom by means of a millimetre scale with a sliding index, the zero of which corresponded with the top of the burner, which was carefully set 28^{mm} below the level of the centre of the refractor. The observations were made by three independent observers, and with two photometers of different construction.

Figs. 1, 2, 3, and 4, show the different observations, and Fig. 5 is the mean result. Fig. 6, is a section showing the relative positions of the apparatus and the sloping bank from which the observations were made. It will be observed that in consequence of the slope there is a slight difference in the distance of the different points of observation from the instrument ranging from 1,284 to 1,357 feet, the maximum difference being 73 feet. In case this difference should have affected the results, we tested the intensity in the same plane at a distance of 1,357 feet, as compared with 1,284 feet, and found that the difference of intensity at these distances could not be measured, so that in our observations the variation due to the sloping face may be disregarded.

It is of course understood that the diagrams refer solely to the refracting part of the first order fixed light apparatus, and that they do not represent quantitative valuations of the different intensities of the light, but only show accurately the direction of the light of maximum intensity, and also the order of the beams of different intensity in the vertical plane.

(Signed) D. and T. STEVENSON.
Edinburgh, 26th February 1861.

CONTINUATION OF OBSERVATIONS BY MR. J. CHANCE.

SINCE my former remarks were written, the Commissioners of Northern Lighthouses have kindly sent me a copy of a report which Messrs. Stevenson had recently communicated upon the subject of lamp-flames, and which gives the experimented results obtained by them in reference to the position of the most illuminating part of the flame.

Those results differ most widely from similar ones previously ascertained at Birmingham by methods of observation not the same as those adopted by Messrs. Stevenson. Even, however, if the same mode of observing the relative intensities of illumination had been pursued in the two cases, a difference in the respective results would have been anticipated, because the flame employed at Edinburgh was higher than the maximum flame used at Birmingham.

But I am by no means satisfied that the admitted difference in the two flames accounts for the whole, or even the greater part, of the discrepancy in the results.

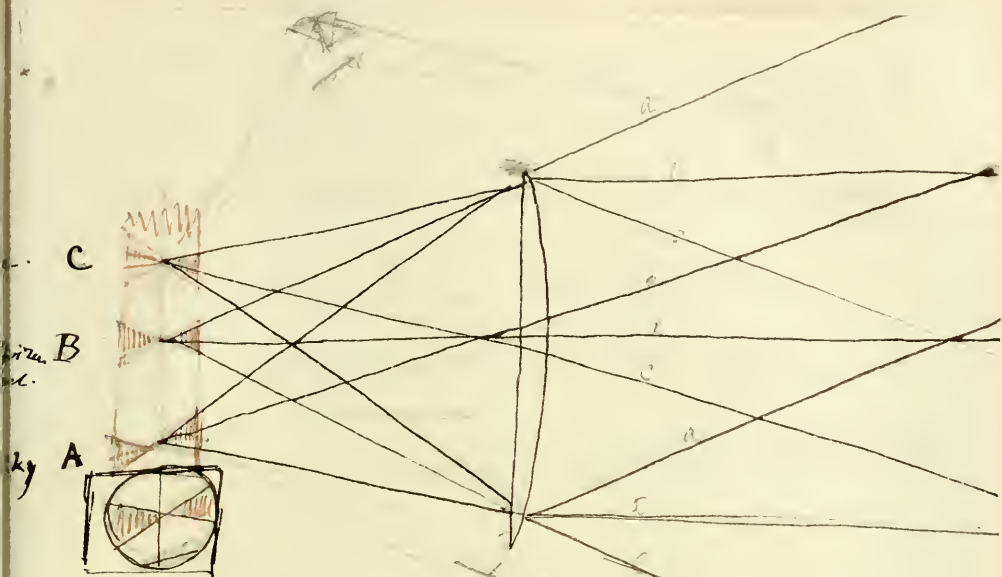
The position of the most effective part of the flame, as determined at Edinburgh, is at least *half an inch* above that ascertained at Birmingham with the *maximum* height of flame then attainable.

In a first order fixed light lately finished for The Smalls, the sea horizon focus has been designedly placed in that part of the flame, which was assumed to be the most effective, but which is fifteen millimetres below the position which the results obtained at Edinburgh would assign as the brightest part.

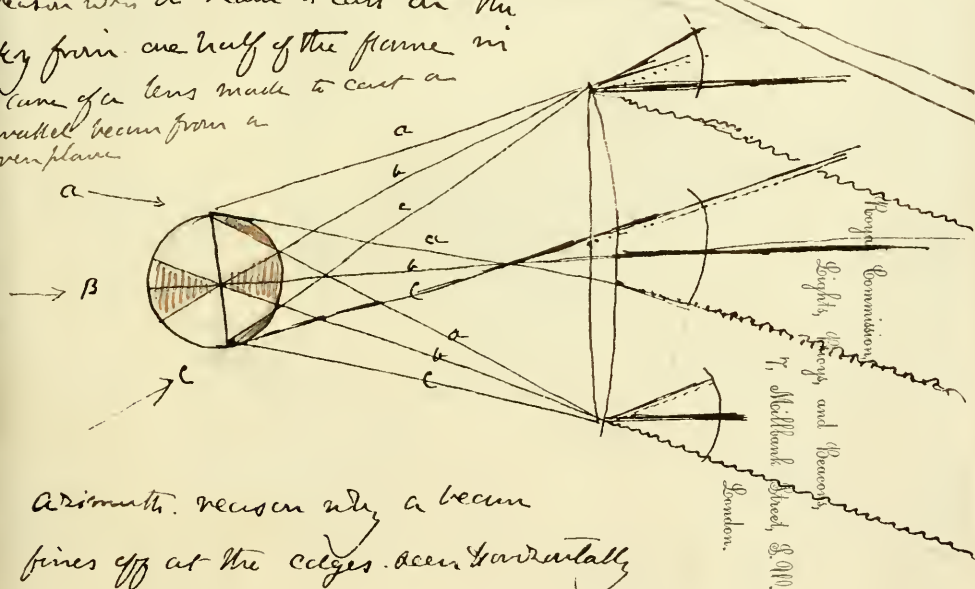
A portion of this distance of 15^{mm}, would be due to the difference between the heights of flame maintained in Scotland and England respectively; but I do not believe that the whole of this discrepancy of the adjustments sanctioned in the two countries is to be explained by the difference of lamps and lamp-flames.

I am very glad to learn that the Trinity House are investigating thoroughly the question of lamps, and the best mode of maintaining high flames; but supposing that point to be settled, and assuming a given height of wick and flame as the standard ones, which are to be always, and everywhere, maintained, there still remains considerable doubt as to the position in relation to the burner (or wicks holder), which the sea horizon focus ought to occupy, in order that the sea horizon may have the brightest illumination; and until this problem is conclusively settled, all optical adjustments of dioptric apparatus must remain indeterminate. It seems, therefore, to be of fundamental importance that measures should be adopted, without delay, to reconcile the experimental discrepancies which at present exist.—March 23, 1861.

JAMES T. CHANCE



reason why a beam is cast on the
sky from one half of the flame in
the case of a lens made to cast a
parallel beam from a
convex plane



asimuth. reason why a beam
flies off at the edges. been horizontally

MS. A. 9. 2. 6. 1851
[Signature]

The following Report was sent by the Commissioners of Northern Lighthouses on 5th February 1861:—

REPORT to Commissioners of Northern Lighthouses

and burner of the different stations on the sloping face of Salisburgh crags were marked by pegs, and ascertained in different ways, all of which gave very

*at present of the House of a
light house lamp the not there
light on the same house of the
invariable outside through the lens.*

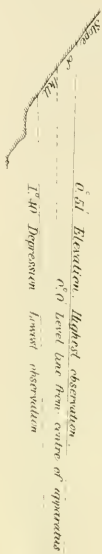
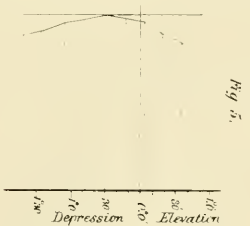
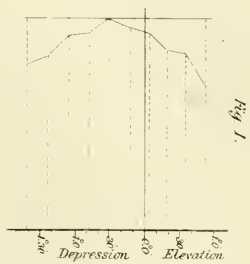
*to compare Stevenson that
drawing made June 13/60*

Report were made at Arthur's Seat, Edinburgh. The lighting apparatus was placed in a lantern glazed with plate glass, the instrument employed being a first-class cylindric refractor, and a four-wick mechanical lamp similar in all respects to those used in the Northern Lighthouses. The place where the observations were made was the steeply sloping face of Salisburgh crags, distant about 440 yards from the experimental light-room. The observations were repeated on several evenings with nearly similar results. Those shown in the diagram were the last made, and from greater precision having been attained in the arrangements, are regarded as in every respect the most accurate. The positions in reference to the lens

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JAMES T. CHANCE



Wm. L. Garrison



ABSTRACTS AND SUMMARY OF EVIDENCE.

The following ABSTRACTS have been made from the Replies to the Questions circulated by the Commission, which are as follows :—

Circular.	No. of Questions in each.	—
I.	26	Sent to the three General Authorities.
II.	19	Sent to Authorities having charge of more Lighthouses than one, so far as was then known.
II. Floating Lights	20	Sent to Authorities having charge of Floating Lights.
III.	58	Sent to Authorities having charge of Lights ; 184 in number.
IV.	69	Sent to Authorities having charge of Floating Lights.
V.	27	Sent to Authorities having charge of Buoys and Beacons ; 184 in number.
VI.	20	Sent to Lloyd's Agents, 184 returns.
VII.	13	Sent to the Mercantile Marine, 1,000 sent out, 144 returns, See Abstract.
VIII.	36	Sent to Mariners ; about 3,000 circulated ; 793 returns.
IX.	25	Sent to Men of Science, 50 returns.
X.	4	Sent to the same, and to Manufacturers.
XI.	35	Sent to Foreign Governments, 13 returns.
XII.	1	Sent to Steam Companies whose vessels pass Colonial Lights, 3 returns.
	353	

CIRCULAR I.

This Circular is made up from Letters sent at various times to the three General Lighthouse Authorities. These were framed as much as possible so as to ask the same questions in all cases; but, from the varying constitution of the authorities, the questions could not be identical, and consequently the replies vary somewhat in their order. The information obtained has been embodied in the Report, and the details are given in Vol. II.

CIRCULAR II.

LIGHTHOUSES.—(GENERAL RETURN.)

I. Name and address of General Lighthouse Authority.

Copies of this form were sent to all Lighthouse Authorities in the United Kingdom whose names could be ascertained, and who appeared to have more Lighthouses than one under their jurisdiction. The Custom House Authorities furnished a list. The Board of Trade were applied to, but they could give no information as to Local Authorities. The returns will be found at the pages marked opposite to the questions in the Circular. See Vol. II.

The description of the several Lighthouse Authorities will be found in the Report at page 22, and a list of the Local Authorities at page 280, Vol. II.

There are in all 184 Authorities in the United Kingdom having charge of Lights, &c., whose existence is now known to the Lighthouse Commissioners; but there are Lights for which there are no returns. None of the Superintending Authorities had lists of the Local Authorities, which they are supposed by the Act of Parliament, in some degree, to superintend; and the returns are incomplete, partly because the Lighthouse Authorities were not ascertained at first, and partly because many of them furnished no returns to the Circulars which were sent to them, though several pressing letters were in some instances written on the subject at long intervals.

2. List of lighthouses under the superintendence of this Authority, with a general Chart showing their positions, and a special return for each lighthouse.

See replies to this question, and lists prepared by the Commissioners. See Vol. II. and Report.

See also the published Admiralty list of Lights. See also the map at the end of Vol. I., on which the Lighthouses and the Local Authorities are marked.

3. General principles which regulate the choice of site for lighthouses.

No general principles regulate the choice of sites in the United Kingdom; they are selected as occasion demands; and much correspondence has taken place amongst the Authorities relative to some particular sites.

The Trinity House choose sites which embrace the largest arcs of the horizon, and "best indicating the dangers of the locality."

The Scotch Commissioners refer to a memorandum by Mr. Stevenson, which states certain general principles; but the Scotch Authority acts, subject to the Trinity House and the Board of Trade. The principle of the Ballast Board is to select the most salient points, but that Authority is subject to the same control. The Local Authorities cannot act upon any general principles.

In France, see page 669, Vol. II., there is a general system; and in countries where a system of lights is about to be introduced, such as Spain, a general principle is to be adopted.

4. What is the height for a light above the water which it is considered inexpedient to exceed?

The average of the opinions of 136 mariners is in favour of 206 feet, see Abstract: page 587, Vol. II. The highest light on the coast of England is Lundy, 540 feet above the sea.

The Trinity House considers that the height is entirely dependant on the locality. The Commissioners of Northern Lighthouses think it advisable, if possible, not to exceed 150 to 200 feet. The Irish Board are of the same opinion. But lighthouses in Scotland and Ireland are placed at a greater elevation, as Barrahead, 680 feet in Scotland, the Seclliffs, 372, in Ireland.

The Local Authorities do not give valuable information; and, on the whole, it appears that on the coasts of the United Kingdom from 150 to 200 feet is the best height for placing a light, so as to gain the greatest possible range and avoid clouds. Every locality, however, has its own peculiarities, which should be considered

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Summary.*

before a light is placed on a new site. For example, a light placed on the cliff above the Needles was found to be so often enveloped in clouds that it was necessary to transfer it to the Needles rocks,—sacrificing range, and expending a large sum, to gain a clearer atmosphere at the foot of the cliff.

The formation of clouds depends on so many local circumstances, that it is impossible to lay down any rule. The atmosphere of the Mediterranean is generally clear, but in particular states of the weather, and with a blue sky and strong wind, thick clouds of mist are sometimes condensed for weeks together about the tops of Gibraltar rock and Apes Hill. The lighthouse at Gibraltar is placed low down on Europa point.

5. The different descriptions of illuminating apparatus (dioptric, catoptric, &c.) employed.

1. Dioptric-lights placed behind glass apparatus which refracts the rays.

2. Catadioptric-lights placed behind glasses, some of which refract, and others both refract and reflect; or behind such glasses, and also in front of glass or metal reflectors, which reflect some of the light towards the glasses which subsequently refract it.

3. Holophotal, consisting of a special arrangement of glass lenses and silvered or glass reflectors, by which it is intended to utilize *all the light* produced from a given source. Some rays are reflected, some refracted; some both reflected and refracted.

4. Catoptric, consisting of lights placed in front of metallic reflectors.

In dioptric and catadioptric lights, so called, a single lamp with 1, 2, 3, or 4 wicks is used. In holophotal lights a single large lamp is occasionally used, as at Hoy in Scotland. Occasionally the principle has been applied to a number of the old parabolic reflectors, each altered, and each with a separate source of light, as at Rona, also in Scotland. Catoptric lights generally consist of from 1 to 30 parabolic silvered reflectors, each with a separate lamp. The aperture of these reflectors is generally large, and the angular aperture and consequent divergence considerable.

6. General principles which govern the selection of the particular description of illuminating apparatus adopted at each site.

No definite principle exists in the United Kingdom.

The Trinity House consider that it is dependant upon the extent of arc to be illuminated.

The Scotch Board state no principle which can be called general, but state considerations which bear upon the flame, and the particular locality. The Irish Board state similar considerations, but also point out the necessity of considering the distinctive character of neighbouring lights. Local Authorities have no general principle. The French have a general principle, which has been laid down and acted upon, see page 669, Vol. II.; and that principle is about to be copied by countries which contemplate establishing a new system of lights. In the United Kingdom, practically, nothing is decided on this point; and dioptric, catoptric, and catadioptric apparatus are placed without reference to site.

7. The different characters of illuminating apparatus (fixed, revolving, &c.) employed.

Fixed, revolving, flashing, and revolving lights with alternate colours, for England; the same for Scotland, with the addition of holophotal and intermittent lights.

In Ireland all the ordinary varieties; Local Authorities throughout the kingdom generally fixed.

By fixed lights are meant lights which are visible in particular directions, either all round, or within an arc

of the circle only. Revolving lights illuminate only certain arcs of a circle at once, and their beams revolve so as to illuminate larger arcs, or the whole circle at intervals. The effect is that of a light waxing and waning for a time, and succeeded by an interval of darkness.

Flashing lights only differ from revolving by the greater rapidity of their intervals.

Fixed varied by flashes is a fixed light of certain power, always visible in certain directions, and varied by recurring flashes of greater power and brilliancy, such as at Grisez, Calais, &c. The effect is produced by making portions of the apparatus fixed and other parts moveable; or by moving the whole apparatus, of which a portion consists of annular bands. The distinction does not exist in catoptric lights, and is liable to this disadvantage: such a light may appear to be a revolving light, when beyond the range of the fixed light.

Intermittent are fixed lights which are from time to time obscured by covering them up with opaque substances. The principle causes a waste of oil; for the light is entirely lost while obscured; whereas in revolving lights it is condensed, and is always visible in some direction. At Rathlin and at Mine Head one-sixth of the oil is burned to waste, and the light might still be mistaken for a fixed or perhaps a revolving light. Similar lights exist in Scotland. The light is much less powerful than the revolving and flashing lights.

Double lights are sometimes used; two entire establishments in separate towers, sometimes two in the same tower. Such lights exist in England, Scotland, and Ireland; though they are not mentioned under this question. See Whitby, where there are two, and the Caskets, where there are three. This distinction is the most costly of all. It is one of those used in France.

8. General principles which govern the selection of the character of the illuminating apparatus (fixed, revolving, &c.), and colour adopted in each site.

There does not appear to be any general principle which is acted upon in the United Kingdom. The English and Irish Boards have regard to other lights in the locality.

The Scotch Board refers to a treatise by Mr. Stevenson, in which the principle stated is nearly the same as that which is stated in the French return; but from the correspondence relative to the lights at the Butt of Lewis and at other sites, it appears that the Commissioners of Northern Lighthouses are not allowed to carry out the principles which are laid down in the treatise to which they refer.

“1st. The most prominent points of a line of coast, or those first made on over-sea voyages, should be first lighted; and the most powerful lights should be adapted to them, so that they may be discovered by the mariner as long as possible before his reaching land.

“2nd. So far as is consistent with a due attention to distinction, revolving lights of some description, which are necessarily more powerful than fixed lights, should be employed at the outposts on a line of coast.

“3rd. Lights of precisely identical character and appearance should not, if possible, occur within a less distance than 100 miles of each other, on the same line of coast which is made by over-sea vessels.

“4th. In all cases, the distinction of colour should never be adopted, except from absolute necessity.”

8. Drawing of each description of illuminating apparatus (dioptric, catoptric, &c.), and each character of light employed.

Drawings have been furnished by the Trinity House. These are lithographs from the trade lists of manufacturers.

The Scotch Board have furnished a great number of well-executed drawings, many of which are representations of apparatus designed by the gentlemen who made the drawings, and which are now in use. The Irish Board have also furnished well-executed small drawings. Of the Local Authorities, many have furnished drawings, which are all bound together and preserved.

10. Fill up Table.

The tables will be found in Vol. II., at the pages marked opposite to this question on the circular.

11. State what stores are usually supplied by open contract, and the means adopted for testing all stores supplied.

Nearly all stores are supplied by open contract, to the three General Lighthouse Authorities. The means of testing them are stated at length in the replies, and seem to be effective.

12. General principles which govern the selection of fog signals, and of the lighthouses to which they are supplied.

None are used, except bells. Many suggestions have been made. See replies to Circular I. 26. at the pages marked.

13. If a general code of tide signals is in force, give it; and if not, state general principles which govern the selection of tide signals, and of the lighthouses to which they are supplied.

No general code exists. No such signals are used at large lighthouses, and every local authority which shows tide lights, or other signals, has its own system of signals and its own code. A national system, and a general understanding on this point, seems to be much wanted; and the more applicable such a system is to the whole world, the better it will be.

14. Nature and dates of any memorials or applications for lighthouses on new or old sites since January 1845, and nature and dates of replies.

Refer to the replies, which are voluminous. See Circular II. for the pages.

15. Total income and total expenditure on maintenance of lighthouses, in each year since January 1845.

By adding together the sums returned by the three General Authorities, the following result is obtained.

	Total Income.			Total Expenditure.		
	£	s.	d.	£	s.	d.
1845	- 434,216	9	11	120,639	7	2
1846	- 411,894	12	7	130,434	8	6
1847	- 435,358	15	1	144,458	7	8
1848	- 436,342	19	5	149,115	5	2
1849	- 430,480	5	9	140,827	7	3
1850	- 374,933	4	11	135,162	9	6
1851	- 403,369	6	1	135,631	2	9
1852	- 395,730	6	1	134,088	8	5
1853	- 422,897	8	0	135,896	4	6
1854	- 313,275	4	1	135,448	18	10
1855	- 311,961	2	6	113,024	15	2
1856	- 352,163	12	3	143,180	13	7
1857	- 310,780	14	10	155,120	11	5
1858	- 296,886	12	6	131,520	0	9

I.

16. Course pursued for ascertaining the value of the various improvements of a scientific character submitted to the General Authority making this return.

*Abstracts &c.
Summary.*

The answers only apply to a particular class of scientific suggestions—those which can be tried experimentally in a lighthouse; and these are practically tested by the engineers employed by the Lighthouse Boards.

The Local Authorities apparently have few suggestions made to them.

17. Dates of all applications by the above General Lighthouse Authority for power to construct or re-construct or alter the lighthouses, since 1st October 1853, with date of final approval; and in case of non-compliance, the reasons given for any deviation from the application.

See the replies, Vol. II. at the pages marked on the Circular.

They are voluminous, and give an insight into the working of the present system of Government. A mass of correspondence has also been sent to the Commission, and some of the subjects therein referred to are mentioned in the oral evidence.

18. Furnish a copy of any General Rules and Regulations issued for the Inspection and management of lighthouses, and copies of all printed forms in use relating to lighthouses, classified and bound.

Copies have been furnished but are not published, as they are very voluminous; the papers are all preserved.

19. General Remarks.

The English and Irish Boards furnish some information relative to their correspondence with the Superintending Authorities, and other matters, which illustrate the action of the present system of government.

The Scotch Authority makes no remarks under this question.

CIRCULAR II.—continued.

FLOATING LIGHTS—(GENERAL RETURN.)

1. Name and address of general Lighthouse Authority.

Trinity House, Vol. II., p. 107; Ballast Board, p. 263; Liverpool, p. 335; Hull, p. 316; Stockton-on-Tees, p. 362; Carlisle, p. 301.

2. List of floating lights under the superintendence of this Authority, with a general chart showing their positions, and a special return for each floating light.

See the returns at the pages indicated in the circular, Vol. II. Trinity House 33; Ballast Board 4; Liverpool 3; Hull 2; Stockton-on-Tees 1; Carlisle 1. Total 44.

3. State general principles which regulate the choice of positions for floating lights.

As near the danger as is consistent with safety, or as leading lights in narrow channels.

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Abstracts and Summary.

4. Number of spare floating lights—where kept moored—proportion of crew attached to them—if fully equipped with stores.

Trinity House 4; Ballast Board 1; Liverpool 2; Hull 1.

5. General principles adopted for distinguishing floating lights from one another by day and by night, and from other vessels by day.

Name written on side; colour; arrangement and number of lights, of masts; masthead balls, and blue lights; shape and rig.

6. Is there any marked peculiarity in the light exhibited by a floating light which ensures it from being mistaken for ships' lights, or others.

Superior brilliancy, variation in intensity, intervals of darkness, colour, number of lights, relative positions of lights.

7. The different description of illuminating apparatus (dioptric, catoptric, &c.) employed.

Catoptric and dioptric. The forms of some of the reflectors used at Liverpool and Hull vary from the others. A dioptric light is used at Stockton-on-Tees.

8. General principles which govern the selection of the particular description of illuminating apparatus (dioptric, catoptric, &c.) adopted in each position.

Catoptric is generally retained, but there are three dioptries.

9. The different characters of illuminating apparatus (fixed, revolving, &c.) employed.

Fixed and revolving.

10. General principles which govern the selection of the character of the illuminating apparatus (fixed, revolving, &c.), and colour, in each position.

Dependent on lights in the vicinity.

11. Fill up table.

See Returns.

12. Drawing of each description and character of illuminating apparatus employed.

Drawings have been furnished.

13. General principles which govern the selection of fog signals.

Gongs are almost always used. Bells were discontinued in Ireland to avoid mistaking them for ships' bells. Guns are proposed; atmospheric whistles were tried, and did not succeed. Bells and gongs at Liverpool.

14. If a general code of tide signals is in force, give it; and if not, state general principles which govern the selection of tide signals, and of the floating lights to which they are supplied.

None are used.

15. Nature and date of any applications for floating lights since January 1, 1845.—Nature and date of replies.

See Returns, which are voluminous.

16. Total income:—Total expenditure on maintenance of floating lights in each year since January 1st, 1845.

See Returns.

17. Course pursued for ascertaining the value of the various improvements of a scientific character submitted to the General Authority making this return.

Consideration by the Authorities and by their scientific advisers, and occasionally experiment.

18. Furnish a copy of any General Rules and Regulations issued for the Inspection and Management of Floating Lights, and copies of all printed forms in use relating to the same.

Copies have been furnished, and are preserved.

19. Dates of all applications by the above General Authority for power to place floating lights in new positions, since October 1, 1853, with date of final approval; and, in case of non-compliance, the reasons given for any deviation from the application.

See Returns.

20. General Remarks.

Under this question the Trinity House, to avoid repetition, have given replies to those questions in Circular IV. which are of a general nature. See page 108, Vol. II.

CIRCULARS III. and IV.

It seems impossible to give the information contained in the replies to these Circulars, in a more condensed form, as abstracts. A number of tables have been constructed from the replies, and these appear in the Report. A reference to the Circulars at the beginning of Vol. I. will show where the information given may be readily found.

The replies are numbered throughout the Appendix, so as to correspond with the Questions in Circulars III. and IV. Attention is directed to Plates 3 and 4, in Vol. I., made from Circular III., showing the income and expenditure; and consumption of oil at lighthouses under the three General Authorities.

CIRCULAR V.

BUOYS AND BEACONS.

A considerable portion of the information obtained in reply to the questions in this Circular has been tabulated, and is printed at page 280, Vol. II. It was not thought necessary to repeat it here.

CIRCULAR VI.

Abstracts and
Summary.

ABSTRACT OF LLOYD'S EVIDENCE.

QUESTIONS.	ANSWERS AND BLANKS. TOTALS.	ABSTRACT OF THE ANSWERS.	
	184	Lloyd's Agents and persons known to them.	<i>Lloyd's Evidence.</i>
1. Have the goodness to write your name and address, and state your occupation.		111 Ports separately named, once or more.	
2. What is the name of the port or place to which your answers refer?	175 Answers 9 Blanks	64 Districts.	
3. Give the title and address of any authority, resident or otherwise, exercising control over, and responsible for the efficiency of lights, buoys, or beacons in the port or place.	91 Answers 93 Blanks	91 Number of Local Authorities named (see Map). The rest refer to districts under the General Lighthouse Authorities.	
4. Do you consider that the port or place and the coasts immediately adjacent are sufficiently well lighted, buoyed, and beacons?	177 Answers 7 Blanks	85 Affirmatives, favourable. 92 Negatives, unfavourable.	
5. Point out any improvement which you can suggest in the position or size of the buoys or beacons, or in the position, number, height, colour, or other peculiarity of the lights or the lighthouse in or near the port or place above named.	70 Answers 114 Blanks	70 Suggest improvements in { Lights 23 Buoy 33 Beacons 18	
6. Name the precise sites on which you would recommend the placing of additional lights, buoys, or beacons, and give your reasons.	106 Answers 78 Blanks	106 Suggest additional { Lights 51 Buoy 33 Beacons 22	
7. What is the combustible (oil, gas, &c.) used in the lighthouses or harbour lights in or near the port or place named?	167 Answers 17 Blanks	167 Name { Oil - - - 115 Other com- { Gas - 45 bustibles { Tallow - 6 Electric light 1	
8. If you are aware that any of the lights as above have been accidentally extinguished or have <i>not</i> been <i>duly exhibited</i> within the last few years, state when, and mention any accident that may have occurred in consequence.	7 Answers 177 Blanks	6 Number of accidents (to lights). 1 Resulting in accidents (to ships).	
9. If you have known any of the buoys to have been displaced within a like period, state when, and for how long, and mention any accident that may have occurred in consequence.	69 Answers, 115 Blanks	60 Number of accidents (to buoys). 9 Resulting in accidents (to ships).	
10. Mention any accident that may be fairly attributed to a <i>want</i> of lights, buoys, or beacons in the locality.	92 Answers 92 Blanks	29 Accidents from want of { Lights 39 Buoy 31 Beacons 22	
11. If tide signals are used, describe them. If no tide signals are used, state whether you think they are wanted, and mention the description which you think best suited for the locality.	51 Answers 133 Blanks	41 Describe tide signals. 10 Think they are wanted.	
12. If fog signals are used, describe them. If none are used, state whether you think any are required, and mention the system you think best suited for the locality, and the position.	55 Answers 129 Blanks	31 Describe fog signals. 24 Think they are wanted.	
13. How are the buoys or beacons in the port or place coloured? What is the form? If they are arranged on any system, describe it.	120 Answers 64 Blanks	120 Describe system { Black and red 47 Black - 42 —colour { Red - 22 White - 9 Cone - 21 Can - 12 " " form { Nun - 7 Square - 7 Barrel - 2	
14. Would you recommend any change in their colour, form, or arrangement?—if so, what is that change?	134 Answers 50 Blanks	12 Advise change. 122 Do not.	

*Abstracts and
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QUESTIONS.	ANSWERS AND BLANKS. TOTALS.	ABSTRACT OF THE ANSWERS.
15. If any local dues are levied on shipping in respect of local lights, buoys, or beacons, state what they are, and to whom they are paid.	71 Answers 113 Blanks	71 Mention local dues.
16. Specify the nature of any complaints that during the last few years may (within your knowledge) have been addressed to the authority aforesaid, with reference to lights, buoys, or beacons under their control, and the result.	23 Answers 161 Blanks	23 Specify complaints.
17. What in your opinion is the general feeling of the mariners frequenting the port, as to the efficiency of the lights, buoys, or beacons in or near it?	151 Answers 33 Blanks	81 Feeling favourable. 70 Feeling unfavourable.
18. So far as you are informed or can ascertain, what is the general feeling amongst mariners frequenting the port as to the local dues collected in respect of lights, buoys, or beacons being excessive or otherwise?	28 Answers 156 Blanks	16 Dues thought excessive. 12 " " otherwise.
19. So far as you are informed, are the local dues so collected applied to the purposes for which they are nominally levied?	62 Answers 122 Blanks	60 Affirmatives. 2 Negatives.
20. Are you aware of the existence of any general opinion in the locality as to the present management of lights, buoys, and beacons by the authority aforesaid?—if so, state shortly what it is.	63 Answers 121 Blanks	56 Opinion favourable. 7 Opinion unfavourable.

Note.—The evidence will be found at length, together with other evidence, under the name of the GENERAL LIGHTHOUSE AUTHORITY having jurisdiction in the district referred to, or under the name of the LOCAL AUTHORITY, when the evidence applies to a place under local jurisdiction. 31 of the returns are placed after the Trinity House return; 26 after the return of the Commissioners of Northern Lighthouses; 14 after the return of the Ballast Board; making 71 returns applicable to the three General Lighthouse Authorities. 113 are placed under the names of the Local Authorities to whose jurisdiction they seem to apply and are not numbered.

*Mercantile
Marine.*

CIRCULAR VII. ABSTRACT OF MERCANTILE MARINE EVIDENCE. SPECIAL QUESTIONS.

NUMBER OF QUESTIONS.	TOTALS OF ANSWERS AND BLANKS.	ABSTRACT.
1. Have the goodness to write your name, state your occupation, and give your address.	114	NAMES.
2. If your evidence is intended to apply to any one particular locality, here write the name of the port, place, or district to which your answers refer.	Answers 114	90 Name 45 separate localities, namely, Aberdeen, 3; Ardsrossan, 1; Belfast, 1; Bristol Channel, 4; Bridgewater, 1; Boston, 1; Clyde, 10; Cork, 2; Dundee, 4; Dublin, 2; Exmouth, 2; East Coast and English Channel, 1; Fal- mouth, 2; Frith of Forth, 2; Foyle River, 1; Greenock, 1; Glasgow, 1; Hull, 5; Harwich, 2; Hartlepool, 1; Ipswich, 1; Jersey, 2; Liverpool, 3; London, 3; Leith, 2; Milford Haven, 1; Newport (Monmouth), 1; New- castle-upon-Tyne, 2; Orkney, 1; Ply- mouth, 6; Padstow, 1; Shoreham, 1; Sunderland, 5; St. Helier and Bay of St. Aubyn, 1; Shields, 3; Stockton, 2; Swansea, 2; Sligo, 1; Solway Frith, 1; Tyne, 5; Tenby, 2; Whitby, 1. 24 Do not name localities.

NUMBER OF QUESTIONS.	TOTALS OF ANSWERS AND BLANKS.	ABSTRACT.
3. Give the title and address of any authority, resident or otherwise, exercising control over or responsible for the efficiency of the lights, buoys, or beacons, in the place to which your evidence applies.	Answers 76 Blanks 38 114	28 Name Local Authorities. 41 Name the General Authorities. 7 Nil.
4. Judging from facts within your own knowledge, or from your own experience, how is the service conducted by the authority having the management of or control over the lights, buoys, or beacons above referred to?	Answers 76 Blanks 38 114	70 Favourable. 3 Unfavourable, see 71, '88, 91. 3 Nil.
5. So far as you are informed, what is the opinion generally expressed by master mariners frequenting the place above named, as to the efficiency and sufficiency of the lights, buoys, and beacons above referred to?	Answers 83 Blanks 31 114	63 Favourable. 16 Unfavourable. 4 Nil.
6. Are any dues levied or collected at the port or place avowedly in respect of lights, buoys, or beacons, other than dues collected for lights, &c., under the control of the Trinity House Commissioners of Northern Lights and Ballast Board?	Answers 74 Blanks 40 114	74 Name 15 localities in which local dues are levied, namely :— Aberdeen. Milford Haven. Bridgewater. Newcastle-on-Tyne. Clyde. Plymouth. Cardiff. Shields, North. Dundee. Shields, South. Falmouth. Sunderland. Hfracombe. Stockton. Liverpool.
7. If no dues are levied or collected avowedly for the maintenance or construction of lights, buoys, and beacons, from what funds are the lights, buoys, and beacons to which your evidence refers maintained?	Answers 53 Blanks 61 114	See Answers, of which no abstract can be made.
8. As a payer of light dues, do you consider the dues above named excessive or otherwise?	Answers 71 Blanks 43 114	30 Excessive. 36 Otherwise. 5 Nil.
9. If you think the charge objectionable, mention any instances in which it presses heavily or unequally, or unjustly : or any facts in support of your opinion.	Answers 50 Blanks 64 114	31 State general objections and mention cases, namely,—General charges, 9; Coasters dues 1; Guernsey and Jersey 1; Ramsgate 1; St. Anthony Light 1; Cumbræ, Glasgow, Clyde, 5; Cobler Buoy 3; Blyth 1; Sunderland 1; Seaham 1; Hartlepool 1; Stockton 1; Middlesbore 1; Whitby, or Staiths 1; Bristol Channel 1; Solway Frith 1; Leith 1; Greenock 1; Bridgewater 1; exemption of ships of Her Majesty's navy 1. Satisfied. 15 Nil. 4
10. If you consider that they are not properly applied, mention any instances of misapplication within your own knowledge, and which you are prepared to substantiate, if necessary.	Answers 46 Blanks 68 114	13 Name instances of improper application of funds, namely,—Funds said to be misapplied at Greenock Harbour Trust 3; the River and Harbour Trust, Glasgow, 3; Trinity House; Tay; Saltash; Ramsgate Harbour; Cumbræ Light Trust; Cumbræ; Clyde, Greenock, and Glasgow; Corporation, Newcastle; Cobler Buoy, Saltash, 2; Tyne, Newcastle; Mercantile Marine Fund; generally. 32 Otherwise. 1 Nil.

*Abstract
Summa
Mercar
Marit*

Abstracts and
Summary.Mercantile
Marine.

GENERAL QUESTIONS.

NUMBER OF QUESTIONS.	TOTALS OF ANSWERS AND BLANKS.	ABSTRACT.
11. Speaking generally, and as a payer of dues levied by the three general Lighthouse Boards in respect of lights, buoys, and beacons, are you satisfied with the operation of the system under which these dues are levied and administered?	Answers 72 Blanks 42 114	24 Satisfied. 44 Otherwise. 4 Nil.
12. If there are any facts within your own knowledge, which you can substantiate if necessary, and which show injurious results from the system above referred to, have the goodness to state the facts.	Answers 38 Blanks 76 114	15 State such facts. 23 Do not.
13. If you wish to suggest any alteration in the system under which the dues last named are levied and administered, here state your views as shortly as possible.	Answers 60 Blanks 54 114	35 Suggest alterations. 24 Do not. 1 Nil.

Note.—1,000 copies of these questions were issued on the 4th of February 1860, and on the 14th of March 112 returns had been received. The names were selected from the following lists:—1, Subscribers to Lloyd's; 2, Members of Marine Boards; 3, Delegates from out ports who attended the Shipowners' Meeting in London in 1858. See Vol. II, page 426 for the names, &c.

CIRCULAR VIII.

Mariners.

MARINERS' EVIDENCE, ABSTRACTS.

QUESTIONS.	TOTALS.	ABSTRACT OF ANSWERS.
1. Are you well acquainted with any particular parts of the coast of the United Kingdom or the Colonies?—if so, name them.	790 Answers	See Index for the coasts named.
2. Are you well acquainted with any foreign coasts?—if so, name them, or those parts of them with which you are well acquainted.	456 Answers 237 Blanks	See Index for the foreign coasts named, which include most of the sea coasts in the world.
3. Do you think that the coasts of the United Kingdom, or the part or parts of them which you have named above, are well lighted?	715 Answers 78 Blanks	564 Direct affirmatives. 110 Qualified affirmatives, suggesting improvements. 7 Qualified negatives, mentioning local defects. 17 Direct negatives. 3 Doubtful. 14 No answer to this question.
4. Do you think that the coasts of the United Kingdom are as well lighted as any of the foreign coasts which you have already named?	586 Answers 207 Blanks	514 Direct affirmatives. 18 Doubtful affirmatives 8 Doubtful negatives 8 Direct negatives. 38 No answer to this question.
5. If you think that the coasts of the United Kingdom are not so well lighted as those of any other country or countries, name those countries in the order in which you prefer their lights.	311 Answers 482 Blanks	200 Prefer England. 33 Name countries preferred, viz. 18 Name countries equal, 45 No opinion. 15 No answer to this question.
6. Have you ever noticed any derangement or irregularity in the light of a lighthouse or floating light; or have you ever known it to go out; or have you ever known a floating light to be off her station?—if so, state when and where.	655 Answers 138 Blanks	477 Have not in either. 111 Have,—either in lighthouse or lightship. 38 Have,—in light-houses and lightships. 23 Doubtful. 6 No answer to this question.
7. What British and what foreign light have you usually seen furthest off, and which of the two has been usually visible at the greatest distance?	655 Answers 157 Blanks	312 Name British and foreign lights seen far off. 149 The British light usually seen farthest off. 74 The foreign light usually seen farthest off. 69 British and foreign lights as equal. 51 Have no opinion. 20 Are double answers.

Naming	25
French	4
Gulf of Finland	3
United States	1
Danish	1
France	25
Spain	1
Russia	3
Sweden	1
Norway	1
Belgium	1
America	5
Italy	1

QUESTIONS.	TOTALS.	ABSTRACT OF ANSWERS.
8. Have you ever felt a want of light-houses or floating lights on any part of the coast, or in any of the channels of the United Kingdom?—if so, where?	645 Answers 148 Blanks	297 Have felt the want, and say so. 31 Have noticed defect, but now remedied. 305 Have not felt the want, and say so. 5 Doubtful. 7 No answer to this question.
9. Do you think that the floating lights generally in the United Kingdom are sufficiently brilliant or distinct in character to prevent them from being mistaken for ship's lights or shore lights?	658 Answers 135 Blanks	488 Direct affirmatives. 102 Qualified affirmatives suggesting improvements. 21 Qualified negatives suggesting improvements. 22 Direct negatives. 22 Doubtful. 3 No answer to this question.
10. Do you think that the fog signals now used in lighthouses and floating lights in the United Kingdom are efficient?	639 Answers 154 Blanks	352 Direct affirmatives. 78 Qualified affirmatives suggesting improvements. 37 Qualified negatives suggesting improvements. 94 Direct negatives. 34 Doubtful. 44 No answer to this question.
11. Do you think that fog signals are used with sufficient frequency in lighthouses and floating lights in the United Kingdom?	604 Answers 189 Blanks	327 Direct affirmatives. 82 Direct negatives. 129 No opinion, or no experience. 66 Suggest improvements.
12. Have you experienced inconvenience from a want of tide signals in light-houses and floating lights—or from their inefficiency—or from a want of uniform system?—if so, state where.	588 Answers 205 Blanks	515 Have not experienced any inconvenience. 50 Have, and suggest improvements. 23 Have had no experience, or have no opinion.
13. Do you think that the coasts of the United Kingdom are well supplied with buoys and beacons?	668 Answers 125 Blanks	545 Affirmatives, direct and general. 83 Qualified affirmatives, with particular exceptions. 12 Qualified negatives, referring to local defects. 15 Direct negatives. 13 No answer to this question.
14. Do you think that the coasts of the United Kingdom are as well supplied with buoys and beacons as those foreign coasts which you have already named at Question 2? If you do not, name the country best supplied.	488 Answers 305 Blanks	442 Direct affirmatives. 6 Qualified affirmatives suggesting improvements. 5 Foreign countries as well supplied. 8 Foreign countries better supplied. 27 Have no opinion.
15. Have you ever felt the want of buoys or beacons on any part of the coast of the United Kingdom?—and if so, where?	647 Answers 146 Blanks	456 Have never felt the want of buoys and beacons. 12 Have felt the want, but now remedied. 174 Have experienced the want, and state where. 3 Have no opinion. 2 No answer to this question.
16. Are you aware of the existence of difficulty in navigating any particular channels, harbours, &c., owing to the system of buoying there used, or the absence of system?—if so, name them, and the defect in each case.	563 Answers 230 Blanks	472 Are not aware of any difficulty. 14 Complain of want of system. 15 Suggest a general system. 52 Mention local defects. 10 No answer to this question.
17. What is the shape and colour of the buoys which you can see best at night?	Shape : 405 Answers 388 Blanks Colour : 698 Answers 95 Blanks	333 Have formed an opinion as to shape - 72 Have not. - 657 Have formed an opinion as to colour - 41 Have not. -
18. If you have ever had occasion to make a claim for the return of light dues erroneously charged, state how often, and the result.	513 Answers 280 Blanks	493 Have not had. 14 Have. 6 No answer to this question.

Be so good as to attend to the directions for signing, &c. at numbers 33, 34, 35, 36.

Be so good as to attend to the directions for signing, &c. at numbers 33, 34, 35, 36.

*Abstracts and
Summary.
Mariners.*

QUESTIONS.

TOTALS.

ABSTRACT OF ANSWERS.

SPECIAL QUESTIONS.

Any of the following questions remaining unanswered to be crossed with the Pen.

- | | | |
|---|---------------------------|--|
| 19. Has it ever occurred to you that any particular system of lighting, different from that at present employed, would have facilitated navigation?—if so, describe the system that would, in your opinion, be an improvement. | 343 Answers
450 Blanks | 249 Have no suggestions to make.
82 Make suggestions or desire alterations.
12 No answers, or no opinion. |
| 20. If you have formed any opinion as to the extreme height above the level of the sea which should not be exceeded in placing the light of a lighthouse on the coasts of the United Kingdom, mention the height. | 335 Answers
458 Blanks | 128 Have not formed an opinion, or indefinite reply.
203 Have formed an opinion and state height—
4 No answer to this question. |
| 21. Can you suggest any improvement in the position, height, nature, colour, or means of identification of any lighthouses, floating lights, buoys or beacons in the United Kingdom?—if so, suggest the improvement, and give your reasons. | 375 Answers
418 Blanks | 193 Are satisfied, and make no suggestions.
171 Suggest alterations as improvements.
11 No opinion, or no answer to this question. |
| 22. Would you suggest the entire removal or a change in the position of any lighthouse, floating light, buoy or beacon?—if so, name it, and state why you think it should be moved. | 331 Answers
462 Blanks | 210 Make no suggestions or are satisfied.
109 Make suggestions for removal or change.
7 No opinion.
5 No answer to question. |
| 23. Would you suggest the placing of a new lighthouse, floating light, buoy, or beacon on any part of the coasts of the United Kingdom?—if so, state where it should be placed, and why. | 466 Answers
327 Blanks | 130 Make no suggestions, or say they are satisfied.
311 Make suggestions for placing new lighthouses.
5 No opinion, or no answer to question. |
| 24. If you are in the habit of passing lighthouses with coloured lights, do you consider that they are discernible at a sufficient distance, and that such lights are sufficiently distinguishable from one another, and from white lights in all weathers? | 509 Answers
284 Blanks | 391 Are generally satisfied with coloured lights.
84 Generally satisfied, but mention defects.
15 Are not satisfied with coloured lights.
19 Have no opinion or experience. |
| 25. If you have formed any opinion as to the comparative merits of each description of coloured light (red, green, blue, &c.), as regards their application to lighthouses and floating lights, state it. | 416 Answers
377 Blanks | 303 Have formed an opinion favourable to
113 Have no opinion. |
| 26. If you are acquainted with any system of colouring lighthouses or lightships by which they are easily seen and readily identified, describe the system. | 352 Answers
441 Blanks | 145 Are satisfied with present system.
90 Are not satisfied, and make suggestions.
117 Have no opinion, or give no answer to question. |
| 27. What system of fog signal applicable to lighthouses and floating lights in use in this or foreign countries do you think best?—Describe it. | 384 Answers
409 Blanks | 51 Have an opinion, and prefer "the present system."
30 Have no opinion. |
| 28. If you think that any uniform system of buoyage applied to coasts, harbours, channels, &c., would facilitate navigation, give your opinion, and describe the system. | 268 Answers
525 Blanks | 148 Are in favour of <i>some uniform system</i> .
86 In favour of present arrangements.
34 Have no opinion. |
| 29. What system or description of tide signals applicable to lighthouses and floating lights do you think best?—and if you are able, give the code for day and night. | 202 Answers
591 Blanks | 65 Are satisfied with present arrangements.
62 Point out defects or improvements.
75 No experience or no opinion to give. |
| 30. Have you ever made any representations or proposals regarding the lights, buoys, or beacons of the coasts of the United Kingdom?—if so, state to whom—the subject—and the result. | 373 Answers
420 Blanks | 62 Have made representation
311 Have not made any. |

Feet	No.	Feet	No.
50	5	250	16
100	24	300	17
150	19	400	6
200	45	500	4
Mean 2.0 feet			

Red	-	-	215
Green	-	-	12
Blue	-	-	5
Red and green	-	-	12
White	-	-	29
Red and white	-	-	30

Gongs	-	-	117
Gongs and bells	-	-	50
Bells as used	-	-	38
Whistles	-	-	10
Guns	-	-	88

successfully	-	-	28
unsuccessfully	-	-	8
uncertain	-	-	2
no reply, result not stated or in abeyance.	-	-	26
	-	-	64

QUESTIONS.	TOTALS.	ABSTRACT OF ANSWERS.	Abstracts and Summary.
31. If you are practically acquainted with any lighthouse or floating light, the light of which has been changed from the catoptric (indicated in the official lists by C.), to the dioptric principle (indicated by D.); and if you have formed any decided opinion as to the superiority of either principle, state it.	221 Answers 572 Blanks	36 Are practically acquainted with } C. 3 lights changed, and prefer - } D. 33 178 Are not acquainted, or give no opinion. 7 No answer to this question.	Mariners.
32. If from your general experience you have formed a decided opinion as to the comparative merits of the two principles named above, state it, and your reasons.	163 Answers 630 Blanks	23 Have formed a decided opinion and give reasons, prefer -	
33. If you have served at sea, state for how long.		7 Have not formed an opinion.	
34. If you command a vessel, give her name and tonnage, and port of register, and if a steamer, her horse power.		9 Name places where lights are excellent.	
35. Be so good as to sign your name, stating your present occupation, and giving an address.		4 No answer to this question.	
36. Date and fold the paper and send it (unpaid) to the nearest post office.		See Index. } P. 145 Pilots. M. 511 Master Mariners. FM. 40 Foreign Masters. S. 10 Surveying Officers. Y. 8 Yachtsmen. E. 1 Elder Brother, Trinity House. RN. 1 Admiral RN. RN. 61 Officers do. CE. 1 Civil Engineer. 15 Other occupations, professions, &c.	
		See Index. }	
		See Index. }	
		See Index. }	
		See Index. }	
		Total - 793	

Note.—In March 1860, after these answers had all been received, printed, and abstracted, a number of forms which were sent to the Secretaries of the Yacht Clubs in April 1859 were received by some members, and were then filled up and sent. They are printed separately and are not included in this abstract.

SUMMARY OF THE EVIDENCE OF MARINERS.

The evidence collected from mariners is, perhaps, the most important, as containing the views and opinions of a very large number, nearly 800, of the persons for whom lighthouses are erected, and buoys and beacons placed. That evidence leads to the following conclusions:—

1st, It appears from the replies to questions 1, 2, 33, 34, 35, that the witnesses are those best qualified by their experience and habits to form an opinion as to British lights, and to compare them with those of foreign countries throughout the world. There are few places of importance in the world which are frequented by traders, which are not mentioned in this list of witnesses; and every part of the coast of the United Kingdom is mentioned by witnesses who are practically acquainted with it.

2nd, It appears that of 715 witnesses who reply to the 3d question, only 17 express a positive opinion that the coasts of the United Kingdom are *not* well lighted.

3rd, Only 8 out of 556 express a positive opinion that these coasts are not so well lighted as the foreign coasts which they know; but out of 306 who reply to question 5, 46 name countries whose lights they consider equal or superior.

These two replies appear to be somewhat contradictory; but taking doubtful affirmatives and negatives together with direct negatives, the result appears to be that from thirty-eight to fifty-six of the witnesses have a general opinion that the lights of certain other countries are nearly as good, if not equal or superior, to British lights. The countries named are given in the abstract.

Foreign places with which the witnesses are acquainted. Questions 1, 2, 33, 34, 35.

Mariners.

Foreign Countries.	Some of the Places embraced under the Principal Head.	Number to whom known.
France -	North-west Coast—Bayonne, Bourdeaux, Brest, Rouen, Calais, &c.	124
Denmark -	River Elbe, Viborg, &c.	60
Norway -	Christiana, Bergen, &c.	29
Sweden -	Gottenburg, Holmstad, Stockholm, &c.	23
Baltic and Gulf of Finland.	Rugen, Gothland, Revel, Abo, St. Petersburg	125
North Sea	-	8
White Sea	Archangel, &c.	9
Gulf of Bothnia.	Finland, North-west coast, &c.	2
Holland -	The Hague	47
Flanders -	Ostend, &c.	11
Belgium -	-	8
Spain -	North Coast, Bilbao, Cape Finisterre, Cadiz, &c.	81
Portugal -	Vigo, Lisbon, and St. Vincent	81
Mediterranean	Gibraltar, Valencia, Gulf of Lyons, Marseilles, Malta, Italian Coast, Sicily, &c.	151
Archipelago -	Smyrna, &c.	8
Black Sea -	Constantinople, Danube, Odessa, Crimea, &c.	33
Prussia -	Dantie, Koniesberg, &c.	27
Africa -	Egypt, Arabian Gulf, Mozambique, Cape of Good Hope, Coast of Guinea, &c.	44
West Indies and West India Islands.	Cuba, Domingo, Jamaica, &c.	47
South America	Amazon, Brazilian Coast, Chili, &c.	103
North America	St. Francisco, Gulf of Mexico, St. Lawrence, &c.	112
China Seas	-	27
East Indies -	Hindustan, Bombay, Malabar, Coromandel, Calcutta, Ceylon, &c. &c.	53
Persian Gulf -	-	5
Australis and New Zealand	-	13
Jersey -	-	3
Guernsey -	-	4
General Foreign	-	19

So far then the evidence is matter of opinion; and the opinion of mariners is very strongly in favour of British lights.

The 6th question was framed for the purpose of

Summary.
Mariners'
evidence.

obtaining from eye-witnesses all possible information as to defects in the practical working of the system in force for maintaining lights.

It must be borne in mind that the men who speak are those who use the lights, and are anxiously watching them at all times and seasons ; men who have the very best opportunity of discovering faults, and the strongest interest in pointing them out.

Of 655, 149 have noticed irregularities either in lighthouses or lightships, or in both. But on looking closely to this evidence, it comes out that in many instances the same mishap has been noticed by a great number of persons, and that the accident has occurred at some period long past, but still fresh in the memory of old sailors ; that a large proportion

of the accidents are the breaking adrift of lightships, and that these are recorded by the Authorities, and remembered as remarkable events by the crews of the vessels.

477 of the witnesses have never, in all their long experience, noticed any irregularities at all ; and the accidents recorded by the rest are, generally speaking, such as are almost inseparable from the service. This testimony then is highly honourable to the Authorities who have charge of the lights.

So is the evidence obtained in reply to the 7th question.

Its bearing can be seen by reference to the two tables which follow.

The following table is abstracted from the evidence given by mariners in reply to Question 7, which comprises three : viz.—

7 a. What British light have you usually seen furthest off ?

7 b. What foreign light have you usually seen furthest off ?

7 c. Which of the two has been usually seen at the greatest distance ?

	1.		2.		3.	4.	5.	6.	7.	8.	9.	10.
	Name of Light.		Nature.		Height.	Miles. visible.	Miles seen.	Noticed by.		Comparison.		
ENGLAND.												
1	Tynemouth	-	* C. rev.	-	154	17	18	11	*	○	*	○
2	Flamborough Head	-	* C. rev.	-	214	19	32	86	14	7	7	-
3	Cromer	-	* C. rev.	-	274	22	32	29	3	2	1	-
4	North Foreland	-	* C. fixed	-	184	18	40?	7	2	1	1	-
5	South Foreland	-	* D. 1st, fixed	-	372	25	40	41	13	2	11	-
6	Dengeness	-	* C. fixed	-	92	14	—	2	3	—	3	-
7	Beachy Head	-	* C. rev.	-	285	22	32	51	10	8	2	-
8	St. Catherine's, I.W.	-	○ D. 1st, fixed	-	178	18	—	5	—	3	—	3
9	Portland	-	○ C. fixed	-	222	19	—	2	—	3	—	3
10	The Start	-	○ D. 1st, flash	-	204	19	18	47	7	10	—	3
11	The Lizard	-	○ C. fixed	-	232	20	30	76	11	12	—	1
12	St. Agnes, Scilly	-	* C. rev.	-	138	16	—	3	2	—	2	-
13	Lundy Island	-	* D. 1st, rev. C. fl. (2 lights)	-	540	30	45	55	15	4	11	-
14	South Stack, Holyhead	-	* C. rev.	-	201	19	—	39	7	5	2	-
15	Skerries	-	○ D. 1st, fixed	-	117	15	—	2	—	1	—	1
16	Calif of Man	-	* C. rev. (2 lights)	-	282	24	42	21	2	—	2	-
SCOTLAND.												
17	Mull of Galloway	-	* C. rev. int.	-	325	23	—	6	3	—	3	-
18	Barra Head	-	○ C. int. rev.	-	680	33	—	8	—	2	—	2
19	Buchan-ness	-	* C. flash	-	130	16	—	2	1	—	1	-
20	Bell Rock	-	○ C. rev.	-	93	15	—	6	2	1	—	1
IRELAND.												
21	Tuscar	-	-	—	101	15	36	29	2	2	—	-
22	Ballycotton	-	○ D. 1st, flash	-	195	18	—	9	—	3	—	3
23	Old Head, Kinsale	-	* D. 1st, fixed	-	236	21	—	9	4	—	4	-
24	Fastnet, Cape Clear	-	* D. 1st, rev.	-	148	18	30	30	9	5	4	-
25	Black Rock	-	○ D. new	-	—	—	—	1	—	1	—	1
								579	112	72	40	*
								witnesses.	184			
								Comparisons.				

The 1st column contains the reply to Question 7 a.

The 2nd, 3rd, and 4th are taken from the Admiralty List of Lights.

The 5th gives the greatest distance at which the light named has been seen by any one of the witnesses who has stated that fact.

The 6th shows the total number of witnesses who named each light in reply to 7 a.

The 7th shows the number of comparisons favourable to the British light named.

The 8th the number favourable to the foreign lights named.

The 9th and 10th give the majorities for or against each light, and the totals show the results of the comparison ; * means British light, ○ foreign, and the majority is 40%.

Similar tables are given under the names of the light, together with the remarks of the Commission.

The lights follow each other in the above table, in the order of their geographical position, sunwise, that is, north, east, south, west.

579 witnesses have mentioned the 25 lighthouses

named in the above table as the British lights which they have usually seen furthest off.

These have made 184 direct comparisons with the foreign lights which they have usually seen furthest off.

And, in reply to the question which of the two has been usually seen at the greatest distance—

111 are in favour of British lights *

72 " " Foreign lights ○

Giving a majority in favour of British lights of 40%.

The following table shows the result of the comparison as it affects the preference shown for the foreign lights named.

* Means favourable to British lights.

○ " " lights elsewhere.

The European lights are arranged in their geographical order, beginning from the north and following the coast. The result is the same as the former table ; but this shows which of the foreign lights are preferred. These are nearly all dioptric, most of them are French, and the rest are generally in southern latitudes, where the atmosphere is clear.

COMPARISON of Fifty LIGHTS in EUROPE and elsewhere with Twenty-five BRITISH LIGHTS.

	Name.	Nature.	Height.	Miles visible.	Seen.	Noticed by	Comparison.	Majority.
1	Dagerort - - -	? fixed - - -	328	21	35	15	* 5	* 5
2	Naze of Norway - - -	D. 1st, flash - - -	164	24	—	7	2	2
3	Hantsholm - - -	? rev. - - -	218	18	—	1	1	1
4	Helgoland - - -	? fixed - - -	221	20	20	5	3	3
5	Schowen - - -	D. 1st, rev. - - -	171	20	23	11	1	1
6	Dunkerque - - -	D. 1st, rev. - - -	194	24	40	2	1	1
7	Calais - - -	D. 1st, flash - - -	190	20	—	2	1	1
8	Grisnez - - -	D. 1st, flash - - -	194	22	35	108	30	18
9	Ailly - - -	D. 1st, rev. - - -	305	27	—	1	2	2
10	Pecamp - - -	D. 1st, fixed - - -	426	18	—	2	2	2
11	Le Heve - - -	D. 1st, fixed - - -	397	20	—	7	2	4
12	Barfleur - - -	D. 1st, rev. - - -	236	22	—	12	5	5
13	La Hagne - - -	D. 1st, fixed - - -	157	18	—	3	3	3
14	Isle de Bas - - -	D. 1st, rev. - - -	223	24	27	2	1	1
15	Ushant - - -	D. 1st, fixed - - -	272	18	—	7	3	3
16	Belle Ile - - -	D. 1st, rev. - - -	276	27	—	1	1	1
17	Cordouan - - -	D. 1st, rev. - - -	207	27	30	5	1	1
18	Finisterre - - -	D. 1st, rev. - - -	474	20	—	1	3	3
19	Bayonne - - -	D. 2d, rev. - - -	603	20	30	3	2	2
20	Bertingas - - -	C. 1st, rev. - - -	365	25	—	2	5	5
21	Roca (Lisbon) - - -	C. 2d, rev. - - -	598	21	—	4	5	5
22	Cape St. Vincent - - -	C. 1st, rev. - - -	221	30	—	13	10	3
23	Tariffa - - -	D. 1st, fixed - - -	132	20	—	1	1	1
24	Gibraltar - - -	D. 1st, fixed - - -	150	15	—	1	2	2
25	Ceuta - - -	D. 1st, fixed - - -	483	23	28	8	1	1
26	Camarat - - -	D. 1st, rev. - - -	426	27	—	1	1	1
27	Perquero.les - - -	D. 1st, flash - - -	262	20	—	1	1	1
28	Genoa - - -	? rev. - - -	370	24	—	8	1	5
29	Leghorn - - -	? rev. - - -	154	19	—	1	1	1
30	Peloas (Faro) - - -	D. 4th, flash - - -	72	13	—	1	5	5
31	Gozo - - -	? rev. - - -	400	24	35	8	1	1
32	Alexandria - - -	? fixed - - -	180	20	—	3	2	2
NORTH AMERICA.								
33	St. Paul's, Gulf of St. Lawrence.	Fixed - - -	140	20	—	—	4	4
34	Mora Havana, W.I.	C. 1st, fixed and flash -	146	18	—	—	2	2
35	Havanna - - -	—	—	—	—	—	4	4
36	Cape Ottawa, U.S.	D. 5th, fixed and flash -	54	12	—	—	1	1
37	Highlands of Navesink, U.S.	D. 1st, 2nd, North, fixed -	248	20	—	—	4	4
		„ South, rev. -	—	22	—	—	2	2
38	Sand Island, Alabama - - -	D. 1st, fixed - - -	152	19	—	—	2	2
39	New Jersey - - -	—	—	—	—	—	—	—
40	Sandy Hook, U.S. - - -	D. 3d, 5th, 6th, fixed -	90	15	—	—	1	1
41	Highland, C. Cod - - -	D. 1st, fixed - - -	195	20	—	—	1	1
SOUTH AMERICA.								
42	Monte Video - - -	Fixed and flash - - -	486	25	—	—	1	1
43	Valparaiso - - -	D. 4th, fixed and flash -	197	20	—	—	2	2
44	Koll - - -	—	—	—	—	—	5	5
45	False Point, Bengal, E.I. -	Fixed - - -	123	18	—	—	1	1
46	Cape Fria, Brazil - - -	Rev. - - -	1000	20	—	—	2	2
47	Pedra Banca, or Horsburgh, E.I.	Rev. - - -	95	15	—	—	3	3
48	Fire Island, U.S. - - -	D. 1st, rev. - - -	89	15	—	—	1	1
49	Bombay Coloba Point, E.I.	Rev. - - -	132	17	—	—	1	1
50	Neuvet, Cuba - - -	C. 1st, rev. - - -	176	15	—	—	1	1
							116	67

The *opinions* given are supported by the *facts* stated, and confirmed by this *comparison*, and the evidence can only lead to the conclusion that the coasts of the United Kingdom are better lighted than those of any foreign country frequented by British ships, or by the foreign traders who have been kind enough to give their evidence.

But while the evidence is so far favourable, the replies to the 8th question show that of 645 witnesses nearly one half have felt a want of lights on some part of the coasts of this kingdom, and their evidence is of great value as showing the points to which the governing authorities should now direct their attention.

So in reply to the 9th question the testimony is not so favourable to the brilliancy of floating lights, and it is evident that great improvements may be effected in them. The reflectors are known to be smaller and less well kept than those on shore. The lights are nearly all catoptric; nevertheless 488 out of 658 witnesses think them sufficiently brilliant or distinct in character to prevent them from being mistaken

for ships' lights or shore lights, and there seems to be little ground for complaint.

In reply to question 10: 352 out of 639 state that they are satisfied with the fog signals; and in reply to question 11, 327 out of 604 say that they think these signals are used with sufficient frequency; but there is a large proportion who are not satisfied, and who suggest alterations and improvements, and here again the testimony is valuable, as showing where defects exist.

Lights on shore are good, but something more is wanted. Floating lights are good, but they might be better. But fog signals have in many instances not been remarked on. The witnesses are generally satisfied, probably because they do not care much about the matter; but many of them have never heard a fog signal at all. And it is manifest that a gong or a bell cannot be heard at any great distance, except under favourable circumstances.

Only 50 out of 588 have felt inconvenience from a want of tide signals. They do not seem to be

Summary.
Mariners' evidence.

required in connection with great lights; but they would be useful, and should be uniform in harbours.

The evidence is highly favourable to the buoyage, absolutely and as compared with foreign buoyage. Only 15 out of 668 express a positive opinion that the coasts of the United Kingdom are not well supplied with buoys and beacons, and only 8 out of 488 express a positive opinion that foreign countries are better supplied.

But in reply to question 15, 174 out of 847 state that they have felt a want of buoys or beacons, and point out where. The buoyage is good, but incomplete, and it might be extended and improved.

In reply to question 16: 472 out of 647 deny that they find any difficulty in navigating, but 79 suggest alterations or wish for a general system of buoyage.

The witnesses appear to feel confidence in their own power of getting over difficulties, but to be aware of the defects in the system, and the wants which exist.

In reply to question 17: the men who use the buoys and beacons state clearly and distinctly the shape and colour which they can see best at night. Conical, that is an angular shape, is best discerned; probably because the lines cross the horizon, and contrast with the curved form of waves.

Black and dark colours are best seen on the water, because the water reflects all the light that is going, and the dark colour appears as a dark spot on a light ground. Red is next to black, probably because that colour is the greatest contrast to the blue or green tinge of the light most commonly reflected from the sky by the sea. White is the worst, obviously because the sea is a light background.

The next question 18, relates to the payment of dues, and is answered by 513, of whom 14 only had occasion to claim a return of sums erroneously charged, but the witnesses are not generally of the class who pay dues.

The series of questions which follow are marked "SPECIAL QUESTIONS," and were intended rather for those who might have given special attention to particular subjects than for the great body of mariners. The answers to these are much less numerous than the replies to questions on matters of fact and opinion, and of daily experience.

In reply to Question 19, 82 out of 343 make suggestions as to alteration in system of lighting; and on referring to the answers, it will be found that they apply rather to particular cases than to any general system.

Question 20 is on a matter of observation, and elicits more evidence. It gives 200 feet as the best height for a light on these coasts, on an average of the opinions of 203 witnesses.

Question 21 asks for suggestions for the improvement of lights, buoys, or beacons: 171 witnesses have suggestions to offer, but many of these relate to local changes.

Question 22 asks for suggestions as to removal or change, and 109 suggestions are made.

Question 23 points to the placing of new lights, buoys, or beacons; and 331 suggest the placing of new lights.

The result, then, of these three questions is, that more witnesses desire the placing of new lights, &c., than the removal or alterations of those which exist. This will afford useful data for the Authorities.

Question 24 asks for opinions as to existing coloured lights, and elicits the fact, that only 15 are not satisfied with them, but 84 others mention defects. There are 509 answers; so this testimony is strongly in favour of the coloured lights which are used.

Question 25 is of some importance as giving a measure of the value of various colours. Thus, *blue* has only 5 advocates; whereas red, singly or in conjunction with white or green, is preferred by 257. Green, singly or with red, is preferred by 24. White is mentioned by 29, who seem to have misunderstood the question. Competent witnesses, then, speaking from their own experience, prefer red to green, and green to blue. The number of witnesses is large, 303; and the majority for red alone great, 215 out of 303.

Question 26 elicits 90 valuable suggestions for

colouring lighthouses and lightships. They can easily be referred to, Vol. II., 561, and are well worth attention as practical suggestions.

Question 27 produces a large majority in favour of gongs and guns for fog signals.

Question 28 shows that 148 are in favour of some uniform system of buoyage. The suggestions made are various; 86 are in favour of the existing state of things, but on examination it appears that of these 30 are pilots, who may be prejudiced in favour of an arrangement which only pilots can understand, and which renders their services more essential.

Question 29 elicits 62 suggestions as to tide signals, which should be considered when a regular system is introduced into that branch of the service.

Question 30 seems to show that these witnesses do not generally make representations as to lights; and Questions 31 and 32 show that, as one of the witnesses remarks, "they don't know the ropes." Catoptric and Dioptric, though they are peculiarly well qualified to express an opinion on the light shown for their special benefit.

The whole evidence is highly creditable to the general intelligence and practical common sense of nearly 800 witnesses, who have replied to this Circular of which 3000 copies were issued; and that evidence is well worthy of attentive consideration.

The following tables have been prepared by Captain Ryder. In the first the number of times that a light is mentioned as seen at great distances (column 6, page 114), is taken as a test of the efficiency of different descriptions of apparatus, dioptric, catoptric, &c.

The test is liable to this disadvantage,—one light may be so placed as to attract the notice of more witnesses than another; for example, Flamborough Head is in the track of colliers, and is mentioned as a good light 86 times, while Barra Head, which is of the same description, is in a more remote situation, and is only mentioned 8 times, Lundy 55 times, and Girdle Ness, which is a dioptric light, and was pronounced by the Astronomer Royal to be well set and with a good flame, is not mentioned at all.

Lundy on the direct comparison with foreign lights (columns 7 and 8, page 114), has a majority of 11; Flamborough has only a majority of 7; but in number of observations Flamborough stands before Lundy, though Lundy has been seen at 45 miles (the greatest distance named), and Flamborough only at 32.

If the greatest distance at which a light has been seen is taken as the test, Flamborough should stand fifth instead of first.

If the largest majority on direct comparisons with foreign lights be the test, it stands fourth.

In the second table, page 118, the lights are arranged according to the order of merit indicated by the number of witnesses who state that they have seen them at great distances, and the number of comparisons with foreign lights is shown. B means better, W worse; thus, Flamborough is thought by 2 observers to be better than Grisevez, by 3 worse, leaving a majority of 1 in favour of Grisevez as compared with Flamborough. The whole of the comparisons are added at the ends of the vertical and horizontal columns, and give the same result as was arrived at in the two former tables. Take for instance Grisevez compared with the British lights, the total is B 30, W 18, that is, 30 observers name British lights they have seen further than Grisevez, although they have seen Grisevez further than any other foreign light; and 18 observers, having the same opinion of Grisevez in comparison with other foreign lights, have also seen it further off than any British lights, giving a majority of 12 in favour of British lights generally compared with Grisevez; but if the number who mention a light be the test, then Grisevez has 108, and no other light comes near it.

Ailly, which the French authorities consider one of their best lights, which was examined by the Commission and the Astronomer Royal, and found to be an excellent light, is only mentioned by one witness, and he considers that it is surpassed by Flamborough and Beachy Head, in which opinion he is unsupported.

TABLE compiled by Captain RYDEN from the MARINERS' EVIDENCE, illustrative of the relative Merits of the CATOPTRIC and DIOPTRIC Lights, as exhibited in English Lighthouses
PREVIOUS to the Researches of the Royal Commission as far as they can be tested by the Evidence of 576 Mariners.

Names of Lighthouses that have been seen furthest off.	Nature of illuminating apparatus.	Height of Light above water.	Miles supposed to be visible.	No. of Observations.	Nature of Illuminating Apparatus in order of Merit.						
					Catoptric revolving.	Catoptric fixed.	Dioptric revolving.	Dioptric flashing.	Catoptric intermittent.	Dioptric fixed.	Catoptric flashing.
Flamborough	-	214	19	86	86	-	-	-	-	-	-
Lizard	-	232	20	76	-	76	-	-	-	-	-
Lundy	-	540	30	55	-	-	55	-	-	-	-
Beechy Head	-	285	22	51	-	-	-	-	-	-	-
Start	-	204	19	47	-	-	-	47	-	-	-
South Foreland	-	372	25	40	-	-	-	-	-	-	-
South Stack	-	201	19	39	-	-	-	-	-	-	-
Fastnet	-	148	18	30	-	-	30	-	-	-	-
Tuskar	-	101	15	29	-	-	-	-	-	-	-
Cromer	-	274	22	29	-	-	-	-	29	-	-
Calf of Man	-	282	24	21	-	-	-	-	-	-	-
Tynemouth	-	154	17	11	-	-	-	-	-	-	-
Ballycotton	-	195	18	9	-	-	-	-	9	-	-
Old Head Kinsale	-	236	21	9	-	-	-	-	-	-	-
Barrhead	-	680	33	8	-	-	-	-	-	9	-
North Foreland	-	184	18	7	-	-	7	-	-	-	-
Mull of Galloway	-	325	23	6	-	-	-	-	-	-	-
Bell Rock	-	93	15	6	-	-	-	-	-	-	-
St. Catherine	-	178	18	5	-	-	-	-	-	5	-
St. Agnes	-	138	16	3	-	-	-	-	-	-	-
Dunegness	-	92	14	2	-	-	-	-	-	-	-
Portland	-	222	19	3	-	-	2	-	-	-	-
Skerries	-	117	15	2	-	-	3	-	-	-	-
Bachness	-	130	16	2	-	-	2	-	-	-	-
Total	-	-	-	576	260 I.	90 II.	85 III.	56 IV.	29 V.	14 VI.	2 VII.

Note.—260 mariners, as seen by the above table, have named 10 revolving catoptric 1st order lights as the lights they have seen furthest off (N.B. there are but 13 of such lights), while out of 10 revolving dioptric 1st order lights only 2 (i.e. are named as seen furthest off, and this by 85 mariners, and of these one is Lundy [noticed by 55 mariners], whose light [540 feet] ensures its being seen a long way off in clear weather. The only result that may safely be arrived at from the above table after making all the very just allowances, deductions, &c. detailed at the bottom of page 116, is that the weight of evidence is inconsistent with any other conclusion than that, generally speaking, the catoptric revolving 1st order lights have *hitherto* been seen further by mariners than the dioptric revolving 1st order lights,

with their low flames, and maladjusted lamps, prisms, and lenses. This may at first sight appear inconsistent with the evidence, that the majority of mariners who profess to know the difference between the two principles, prefers, in accordance with the opinion of the Commissioners, the dioptric to the catoptric principle; but the apparent discrepancy is easily explained. It is remembered how wretched is the state of the numerous inferior lamps on the catoptric principle, and how every small port he enters in the United Kingdom, while the smallest dioptric lights he meets are comparatively very efficient. The reason why our magnificent dioptric apparatus has proved so inefficient is mentioned in the Report, and illustrated in the Whitby paper.

TABLE constructed by Captain RYDER from

ENGLISH LIGHTS.										FOREIGN LIGHTS IN EUROPE.									
NAME.	Description.	Order or No. of Burners.	Character.			Height above Water.	No. of Observations.	Designation of Lamp		Name.	Grisez.	Daguerst.	Cape de Vincent.	Barleur.	Schouens.	Centa.	Gauca.	Goza.	Naze of Norway.
			Revolving.	Fixed.	Flashing.			Designation of Lamp.	Hours per gallon.										
Description	Order or No. of Burners	Revolving	Fixed	Flashing	Height above Water	No. of Observations	Description	Hours per gallon	Description	Grisez	Daguerst	Cape de Vincent	Barleur	Schouens	Centa	Gauca	Goza	Naze of Norway	
Flamborough	C.	21	1	—	214	86	Argand, parabolical reflector.	5'159	{ B 2 W 3	{ B 1 W 2	{ B 1 W 1	—	{ B 1 W	—	—	—	{ B 1 W	—	—
Lizard	C.	19	—	1	—	229	76	Argand, parabolical reflector.	5'710	{ B 1 W 4	—	{ B 2 W 1	—	—	{ B 1 W 1	{ B 3 W 3	{ B 1 W	—	—
Lundy	D.	1st order	1	—	—	540	55	Concentric wick lamp, lenses, and prisms.	10'069	{ B 5 W 2	—	{ B 1 W	—	—	—	—	{ B 1 W 1	—	—
Beachy Head	C.	30	1	—	—	285	51	Argand, parabolical reflector.	4'362	{ B 5 W 3	{ B 1 W 1	—	{ B 1 W 1	—	—	—	—	—	—
Start	D.	1st order	—	1	—	204	47	Concentric wick lamp, lenses, and concave mirrors.	8'795	{ B 3 W	—	{ B 1 W 1	{ B 2 W 2	—	—	—	{ B 1 W 1	—	—
South Foreland	D.	1st order	—	1	—	372	41	3 concentric wick lamp, refractors and reflectors.	8'866	{ B 11 W 2	—	{ B 1 W	—	—	—	—	—	—	—
South Stack	C.	21	1	—	—	201	39	Argand, parabolical reflector.	4'921	{ B W 1	—	—	{ B 1 W 1	—	—	—	—	—	—
Fastnet	D.	1st order	1	—	—	148	30	1 concentric wick lamp, zones.	10'579	{	—	—	—	—	—	—	—	—	—
Tuskar	C.	1st order	1	—	—	101	29	Burners, parabolical reflectors.	5'887	{	—	—	{ B 1 W	—	—	—	—	—	—
Cromer	C.	30	1	—	—	274	39	Argand, parabolical reflectors.	4'524	{ B W 2	{ B 1 W	—	—	—	—	—	—	—	{ B 1 W
Calf of Man	C.	1st order	1	—	—	375	21	—	4'437	{ B 1 W	—	—	—	—	—	—	—	—	—
Tynemouth	C.	18	1	—	—	154	11	Argand, parabolical reflectors.	5'967	{	—	—	—	—	—	—	—	—	{ B 1 W
Ballycotton	D.	1st order	—	1	—	195	9	1 concentric wick lamp, vertical reflectors.	12'372	{	—	—	—	—	—	—	—	—	—
Old Head, Kinsale	D.	1st order	—	1	—	236	9	—	7'793	{	—	—	{ B 1 W	—	—	—	—	—	—
Barrahead	C.	1st order	1	—	—	680	8	—	5'558	{	—	—	{ B 1 W 1	—	—	—	—	—	—
North Foreland	C.	1st order	—	1	—	203	7	Argand, parabolical reflectors.	6'230	{ B W 1	{ B 1 W	—	—	—	—	—	—	—	—
Mull of Galloway	C.	1st order	1	—	—	325	6	—	6'833	{	—	—	{ B 1 W	—	—	—	—	—	—
Bell Rock	C.	1st order	1	—	—	90	6	—	6'769	{	—	—	{ B 1 W 1	—	—	—	—	—	—
St. Catherine's	D.	1st order	—	1	—	178	5	3 concentric wick lamp, refractors and reflectors.	10'162	{	—	—	—	{ B 1 W 1	—	—	—	—	—
St. Agnes, Scilly	C.	30	1	—	—	138	3	Argand, parabolical reflectors.	4'451	{ B 1 W	—	—	—	—	—	—	—	—	—
Dungeness	C.	18	—	1	—	92	2	Argand, parabolical reflectors.	6'790	{ B 1 W	{ B 1 W	—	—	—	—	—	—	—	—
Portland	C.	17	—	1	—	222	3	Argand, parabolical reflectors.	5'502	{	—	—	{ B 1 W 1	—	—	—	—	—	—
Skerries	D.	1st order	—	1	—	117	2	Concentric wick lamp, refractors and prisms.	9'008	{	—	—	—	—	—	—	—	—	—
Buchanness	C.	1st order	—	1	—	130	2	—	5'233	{	—	—	—	—	—	—	{ B 1 W	—	—
TOTALS	C 16 D 8	—	13	8	3	—	577	—	—	—	{ B 30 W 18	{ B 5 W 5	{ B 5 W 3	{ B 6 W 6	{ B 1 W	{ B 1 W 1	{ B 1 W 5	{ B 1 W 1	{ B 2 W

Circulars IX. and X.

It has been thought advisable not to attempt to abstract the Answers to these two Circulars. The opinions and suggestions of the gentlemen who have been so kind as to furnish replies are best given in their own words, and they can easily be referred to. See Circular and list of names, Vol. II. at the beginning, and at page 589.

There are two questions in Circular III. the answers to which deserve some more particular notice.

Questions 43 and 44 relate to income and expenditure, and when they were first prepared the Commission had no reason for supposing that to answer them would occasion any serious amount of trouble. As each light has an income derived from dues levied on passing ships, and an expenditure, it seemed to be a simple question to ask what that income and expenditure was in certain years or quarters.

The questions were accordingly put, and the answers have been given, but to prepare these replies has occasioned a vast amount of trouble. To have answered the questions in the form in which they were originally put would have cost much more.

It appears that in England, Ireland, and Scotland dues are collected for the three countries. A ship which is liable to pay dues in respect of an English light may touch at an Irish port, and pay there, and so the tolls are not separately collected.

Formerly, a system of cross-counting existed, by which the dues were apportioned, and the amounts for each light kept separately; but this system was abandoned by direction, as it is stated, of the Board of Trade, and consequently the following process had to be gone through before the income of any light could be ascertained. The whole income of the Authority making the return had to be broken up into sums of sixteenths of a penny, and allotted to each lighthouse passed in each voyage of each ship that had entered a port in the country during the period; and the Authorities had then to communicate the result of their calculations to each other before they could make up the returns. In some cases, a further calculation had to be made, in consequence of reductions in dues, and the labour was so enormous that the Commissioners altered their questions, when they were informed of their effect.

They thought, however, that it was necessary to the completeness of their inquiry, to have some information on this important subject; they retained part of the questions, and returns have accordingly been obtained.

The Commissioners were not directed to report and have not reported on the subject of dues, but it formed part of their duty, under the head of economy, to ascertain how the accounts were kept, and ample information on this head may now be gathered from the returns.

It is evident that, so long as dues are levied as at present, the relation between the probable expense of erecting and maintaining a new light on the one hand and its probable income on the other, will continue (whether rightly or wrongly is a matter of opinion) to weigh with the Lighthouse Authorities, when considering a demand for a new light, and will assist or retard its erection. The annual income of each existing lighthouse has been ascertained for the Commissioners, and printed in the replies to the Special Returns, Circular III., and will prove for some time to come of great value to the authorities when considering what toll should be levied in respect of any new lighthouse or floating light. Knowing from the returns now printed what a given toll per ton produces from the same trade in the nearest lighthouses, it will be easy to name a toll per ton which shall produce, if thought advisable, a yearly sum equal in amount to the cost of maintenance and the interest on the first outlay or within certain limits to any less or greater sum.

A diagram has, therefore, been prepared, and is placed at the end of this volume, and an inspection of it will best show what is the proportion between the income and expenditure of various lights.

The incomes of English lighthouses are generally very large. The Scotch lighthouses on the east coast have large incomes also, but the highest Scotch income is far below that of twelve English lights, and the income of the Smalls, 22,759*l.*, is very far above the highest Scotch income. The Bell Rock is 5,134*l.*, and that exceeds the highest Irish income, Wicklow 3,510*l.* Every lighthouse in England, more than pays its expenses, but a large proportion of the lights in Scotland and Ireland do not. In short, it is manifest that the income and the expenditure of different lighthouses now bear no sort of proportion to each other, for the expenditure is about the same in lights of the same size in the whole of the United Kingdom. From this it appears that the principle of keeping the income of a light proportionate to its expenditure, has not been carried out, and that the distinction between England, Scotland, and Ireland in this respect is not of much importance.

A vessel arriving, say at Liverpool, from America, must pass English and Irish, perhaps Scotch lights; she may come in from the north or the south; she may be driven out of her course; and many vessels are in fact wrecked on the western islands of Scotland, and on the west of Ireland, and make these coasts when they intend to make some other. There are few lights on the western coasts, and they have small incomes; but it does not seem to make much difference to the crew and owners of a vessel, if wrecked for want of lights, whether the dark coast forms part of one or of the other division of the United Kingdom. And yet it is frequently argued that because a smaller amount of dues is levied from passing ships in Scotland and Ireland, therefore less money should be spent in erecting and maintaining lights on the dangerous coasts which are least visited.

That principle, if carried to its legitimate conclusion, would leave the whole west of Scotland and of Ireland, the most dangerous of the coasts of this kingdom, in darkness.

Questions 18 and 19 of Circular VI., and Questions 7, 8, 11, 12, and 13 of Circular VII. also relate to dues. From the first two it appears that so far as the agents for Lloyd's and those whom they have consulted are aware, there is no very general feeling hostile to the existing system of levying dues, or to their application. Only 16 witnesses of the first class think dues excessive, or are aware of such an opinion. There are 184 returns, and a much larger number of persons interested had the opportunity of complaining if so disposed. The opinions of a still larger number are expressed by Lloyd's agents, and have been collected by them. Of the second class of witnesses: The mercantile marine, those on whom the dues fall; a still larger number, nearly a thousand, must have received the circular; for only a very few of the papers sent out were returned by the post office. The number of complaints in the replies to Questions 7, 8, 11, 12, and 13 prove that whatever may be the objection to the existing method of raising funds for lighthouse purposes, the majority of those who pay the dues have no grievance which they considered of sufficient importance to induce them to complain. Only 35 out of nearly 1,000 suggest an alteration in the system under which dues are levied upon them, and administered by the three General Lighthouse Authorities; and of the 31, who think particular dues "excessive" or "objectionable," a large proportion specify Local Dues, and in some cases the same charges are maintained by several independent witnesses.

These questions, then, have elicited the fact, that those who pay the dues are not generally dissatisfied with the existing state of things; and the replies to Questions 43 and 44 in Circular III. show what that state of things now is so far as concerns the levying of light dues and the expenditure on lighthouses.

MINUTES OF EVIDENCE

TAKEN BEFORE THE

COMMISSIONERS APPOINTED TO INQUIRE INTO THE CONDITION AND MANAGEMENT OF LIGHTS, BUOYS, AND BEACONS.

Thursday, 29th November 1860.

PRESENT :

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON, R.N.
Captain ALFRED PHILLIPS RYDER, R.N.
JOHN HALL GLADSTONE, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

PETER HENRY BERTHON, Esq., examined.

P. H. Berthon,
Esq.

29 Nov. 1860.

1. (*President.*) You are Secretary of the Trinity House?—Yes.

2. When were you first appointed?—I was appointed Secretary in April 1856, having then been 40 years in the service.

3. In whom is the appointment of secretary vested?—In the corporation of Trinity House. It is a recommendation generally from the Committee of the Wardens, confirmed by the court of the Corporation.

4. Who is it that prepares the annual estimates which are now submitted to the Board of Trade?—They are prepared in the different departments, examined in the Accountant's office, and approved by the wardens, and laid on the table of the court, and, when approved by the court, are sent to the Board of Trade.

5. What is the exact date that you would fix as the period when the Lighthouse Service of the Trinity House came under the control of the Board of Trade?—The 1st of October 1853, under the Merchant Shipping Act of 1853.

6. You consider, I presume, that by that act a section only of the Trinity House, namely, that which has to do with the management of lighthouses, buoys, and beacons was to come under the control of the Board of Trade, and not the Corporation of Trinity House as a corporation?—Not as a corporation, but as respects that section only of its functions which relate to the management of lighthouses, buoys, and beacons, and ballastage, which were made subject to the control of the Board of Trade as respects expenditure by that Act.

7. Do you think you can furnish the Commissioners with a copy of the estimates of expenditure on lighthouses as they were prepared for the Trinity House before the passing of the Merchant Shipping Act, and a copy of the last or present estimates?—There were no estimates prepared previously to the passing of the Act of 1853. The expenses were incurred as they became necessary, and they were considered, of course, with reference to the means of the Corporation to incur them, but no detailed estimate was made annually of what might be expected to be incurred in each year. At the end of the year we had to make a return to Parliament of all the expenses for the maintenance of lighthouses, together with the revenue from the lighthouses.

8. Can you produce a copy of such return?—I have not the parliamentary papers with me, but they are filed. We have every one of them, year by year, from 1834, I think, down to 1853, I mean the annual returns made to Parliament showing the amount of the collection and expenditure for each lighthouse.

9. Then that return is no longer given, made out in that shape?—No.

10. Since the passing of the Act of Parliament?—Yes; we account now only to the Board of Trade for the revenue and the expenditure, and they account to Parliament.

11. (*Captain Ryder.*) Is the account, as laid before Parliament now, more or less explanatory than it was before?—Much less so. I might even go further, and say that it gives no explanation now, but merely a single item, the gross receipt on one side of the collection for lighthouses, buoys, and beacons, and the gross expenditure on the other.

12. Is the account which you give in to the Board of Trade more or less explanatory than that which you previously gave to Parliament?—It is considerably less explanatory, inasmuch as the Board of Trade do not require the amount collected for any individual light, or its expenses; I do not know whether they can get at the expenditure for any particular light, but if they can it must be by an analysis of the accounts; they are not shown in a single item, as the Corporation of Trinity House used to show them to Parliament.

13. (*President.*) What was the date of the Act of Parliament requiring the Trinity House to purchase certain private lights?—It was the 6th and 7th of William the 4th, chapter 79, section 42, passed on the 13th of August 1836. Under the Act of the 3rd of George the 4th, the Corporation were empowered to appropriate a certain amount of funds, which were then in their hands, to purchase the private lights, and under that Act of Parliament the purchase of the Flatholm, the Fern, and the Burnham, were respectively made in 1823, 1825, and 1829.

14. Can you state whether previously to that there had been other or frequent Acts of Parliament, directing the Trinity House to deal with their funds in a particular way?—I am not aware that, until 1822, there ever was an Act of Parliament directing the Corporation of Trinity House to deal with their funds in any particular way.

15. (*Captain Ryder.*) Has the action of the Merchant Shipping Act necessitated any increase of correspondence on the part of the Trinity House?—Certainly.

16. Can you give any estimate of the proportionate increase in the correspondence; for example, has it doubled?—I should say that it has more than doubled. There is a very large increase; in 1859 we received 240 letters from the Board of Trade, and we wrote to them 211, and this year there is about the

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same proportion; all that correspondence, or nearly so, originated in consequence of the control of the Board of Trade.

17. Has your correspondence with the Scotch and the Irish Boards been increased by the action of the Merchant Shipping Act?—I cannot say that it has been increased much, and for this reason that the Corporation exercised a control over those two Boards, to a certain extent, previously to the passing of the Merchant Shipping Act.

18. The same control as there is now?—I think more; a greater control.

19. (*President.*) Have those letters principally been on the subject of expenditure, or discussions upon matters entirely connected with the lighthouses themselves, their erection, or the nature and description of the light?—I mean in the majority of cases?—The majority of cases of course would apply to questions connected with the expenditure.

20. Has there been any increase in the establishment, although there has been an increase of clerical labour?—Not since 1854. In 1854 an arrangement of the official establishment was made by the Board of Trade under the powers given to them by the Act of Parliament.

21. When the Board of Trade settled the establishment officially, was it done by increasing or diminishing the clerical staff?—They took the clerical staff as we had it.

22. (*Captain Ryder.*) And left it so?—Yes; at the time that the official establishment was defined by the Board of Trade, the Corporation had found it necessary to employ three extra clerks, who have been since retained with the special concurrence of the Board of Trade.

23. Many of the questions which have been addressed by this Commission to the Authorities of the Trinity House have, I conclude, passed more or less under your review?—They have. I have seen all of them, but they have been so numerous that I have not had an opportunity of giving them all very full consideration.

24. Since the time when the Board of Trade has exercised control, it may be stated, may it not that a new system of accounts has been adopted different from that which existed before you were placed under the Board of Trade?—Certainly.

25. You have stated that many of the questions that have proceeded from this Commission have come more or less under your review?—I have.

26. Could you, under the old system of accounts at the Trinity House, have answered those questions more or less readily than under the present system?—Many of them more readily.

27. Is there any longer any payment of charities out of the moneys received for lighthouse dues to persons who are other than pensioners of the establishment?—None. The incumbents of the pensions at the passing of the Act of 1853, were to, die out. I think the Commissioners will see by the Return made to Parliament by the Board of Trade that the pensions have been reduced from about 20,000*l.* to about 10,000*l.* per annum.

28. Then out of what fund is that remaining sum paid?—The Mercantile Marine Fund was made chargeable with all the pensions then subsisting.

29. Then virtually it comes out of the light dues?—Clearly; but it is a vanishing amount.

30. (*Mr. Gladstone.*) Does that include the pensions given to supernannated lightkeepers?—No; it does not; those are pensions and allowances of the establishment allowed by the Merchant Shipping Act to be given by the Corporation, with the sanction and concurrence of the Board of Trade.

31. Do you think there is any minimum rule as to the number of cubic feet to be allowed for sleeping accommodation for lighthouse keepers in the lighthouses of England?—I am not aware of any minimum.

32. (*Captain Ryder.*) Is there any difference in the plan adopted now by the Board of Trade and that by the Trinity House previously to 1854, to ascertain

the views of the Shipping Interest regarding the necessity of erecting a lighthouse, or making a change in an existing lighthouse before tolls are levied?—There is; the system pursued by the Corporation previously to 1854 was this; when the necessity for a lighthouse in any particular position had been represented to them, and they had satisfied themselves that it was necessary, petitions were invited from the trade particularly interested in the locality; subscription parchments, prepared by the solicitor, were sent to each of those ports, to be signed by the parties interested in the trade, who prayed the Corporation to establish the light, and who, in the same document, undertook to pay such reasonable toll for the maintenance of the light as might be imposed upon it, and an application was then made to the Crown for a patent empowering the Corporation of Trinity House to levy such tolls. For each light so erected a patent was issued under the Royal Seal enabling the Corporation to erect a light and to levy a specified toll. That was the course pursued previously to 1854. With respect to any system that is now pursued by the Board of Trade, I am unable to give the Commissioners precise information.

33. Why does not the Trinity House now collect the suffrages of the Shipping Interest as it did before?—Because no patent is now necessary for the collection of the tolls.

34. (*Mr. Gladstone.*) With respect to the erection of a new lighthouse, or an alteration of any existing lighthouse, is that decided at the general court of the Corporation, or in the Lighthouse Committee?—In the general court of the Corporation.

35. The Lighthouse Committee has nothing to do with it?—I do not say that exactly, because the Lighthouse Committee may be consulted on the subject; but the determination to establish or to alter a light is upon the decision of the court, and not with the Lighthouse Committee alone.

36. The Lighthouse Committee, in point of fact, is rather an executive than an administrative body?—Yes; clearly.

37. (*Captain Ryder.*) In what respect has the position in which the Trinity House stood to the Shipping Interest been changed by the Merchant Shipping Act?—Since the passing of the Merchant Shipping Act the Corporation of Trinity House have not been so directly in communication with the Shipping Interest as previously; the Board of Trade acting now intermediately between the two.

38. (*Mr. Gladstone.*) Was not the question of the necessity of a lighthouse in a particular spot more fully ventilated under the old system than at present?—I think it was.

39. (*President.*) Could you furnish the Commissioners with a copy of the last prospective annual estimate that was submitted to the Board of Trade?—Yes.

40. Will you also furnish the Commission with the last account laid before the House of Commons before the passing of the Merchant Shipping Act?—Yes; that will be the account for 1852. I do not think that we rendered an account for 1853, because the Act of Parliament came into operation previously to the expiration of that year. I therefore think that the last account rendered to Parliament was for 1852.

41. The Commissioners would also like to have a copy of the last quarterly expenditure account that was sent to the Board of Trade?—I will supply it.

42. Could you now state, without referring to documents, whether there is an item in your annual estimates, which are submitted to the Board of Trade for "Miscellaneous"?—Yes; there is.

43. Can you state to the Commission whether that miscellaneous estimate is a smaller one now than it was before the lights were placed under the Board of Trade?—We made no estimate previously. The amount is about 4,000*l.* a year, and includes law charges, travelling expenses, expenses of the committees of inspection, &c., and the annuities with which the private lights had been chargeable when we pur-

chased them. These are things that we cannot classify under the different heads that the Board of Trade have given us.

44. In the year 1836, the Trinity House was called upon to purchase, and to take the management of all the coast lights, then in the hands of private individuals?—Yes.

45. And the amount paid, as awarded by juries, for those lights, amounted to 1,182,543*l*.?—The total sum paid for those Lighthouses, the stores, &c., therein, and for the tolls chargeable in respect of them, amounted to 1,200,246*l*. 16*s*. 4*d*., as shown by a return in the Appendix to Report of Select Committee of 1845. Fo. 443 et seq.

46. Which money was borrowed from the Bank of England, and from individuals on the security of the light dues?—Yes.

47. What was the amount of interest that you were required to pay on that sum?—We first paid 4 per cent., which was reduced to 3 per cent in 1844.

48. Do you think that the Trinity House, taking into consideration this large sum, which they were obliged to pay for private lights, by the Act of 1836, as awarded by juries, spreading that sum over the 70 lighthouses in the kingdom under their management, could form an approximate estimate of the average cost to the Shipping Interest of this country of each of those lighthouses?—I do not think we can give the cost of the very ancient lighthouses.

49. (*Captain Ryder*.) Did the Corporation propose to reduce the light dues in 1847 and 1852, and, if so, by what amounts?—Yes. I cannot say to what amount in 1847—but in 1852 the amount was 40,800*l*.

50. What was the answer of the Board of Trade to that proposition?—With respect to the reduction of 1847, I can give this answer:—The light dues having been given under the Act of 1836 as security to the

parties from whom we were to obtain loans, the then president of the Board of Trade thought that we could not make any reduction of the light duties until the whole of the debt had been paid off, inasmuch as it would be depriving those parties of their security.

51. That was with regard to 1847?—Yes.

52. Was the same answer given to the application for 1852?—In 1852 an application was made, and a reduction took place in the coasting trade to the amount of about 15 per cent. That reduction was then effected, but it must be understood that it was five years later, when the debt had been considerably reduced, and when the same objection could not be validly taken, and that a large reduction had already been made in 1849.

53. What reductions were made in the light dues in consequence of the suggestions of the Trinity House in 1849 and 1852?—The reduction in 1849 was estimated at 79,800*l*. That in 1852, at 40,800*l*.

54. To what trade did those reductions apply?—Principally to the coasting trade in both instances.

55. What reductions have been made since?—For this information I beg to refer to Parliamentary Paper No. 80, of last session.

56. Is there any retirement or allowance of Elder Brethren?—No.

57. How many Elder Brethren are there over the age of 70?—Two.

58. Are there any who are incapacitated for active duties?—No. I cannot say that any of them are incapacitated.

59. What duties do the three oldest Elder Brethren perform?—They take their regular turn of duty at the Trinity House; they do not, of course, go so often afloat; but they perform all the duties of the Committees to which they belong.

Mr. ROBIN ALLEN examined.

specifications, and copies of the drawings that accompanied the specifications?—Yes.

63. Can you state to the Commissioners who made those drawings?—They were used for the general purposes of the Trinity House at that time, and were originally prepared by Mr. Wilkins. Since then modifications have been made and new drawings prepared by Mr. Walker.

Adjourned.

Friday, 7th December, 1860.

PRESENT:

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON, R.N.

Captain ALFRED PHILLIPS RYDER, R.N.

JOHN HALL GLADSTONE, Esq.

SAMUEL ROBERT GRAVES, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

The Right Honourable THOMAS MILNER GIBSON, M.P., and THOMAS HENRY FARRER, Esq., examined.

64. *President. (To Mr. Milner Gibson.)* You are President of the Board of Trade?—Yes.

65. How long have you been President of the Board of Trade?—I think I became President in the summer of 1859.

66. The Commissioners wish to ask how far, as the member of the Government presiding over so great a department as the Board of Trade, and one comprising such a diversity of business, you charge yourself with the management of that portion of its business which relates to lighthouses, and how far you have been able, during the time of your presidency, to make yourself acquainted with the usual course of that business?—The question embraces two or three points; the fact is, that questions are prepared and submitted in a clear form to the President by those who have examined them; and it is not very difficult to form an opinion of the right course to be taken in any particular case that arises. Having the advantage of the opinions of those who are professionally acquainted with the subject

under consideration, it is like any other branch of business in a public office; of course the two sides of each question are submitted, and it is for me, at the Board of Trade, to decide upon the whole which is the right course to be taken, so far as our jurisdiction goes.

67. You have stated that it is not very difficult to come to a conclusion as to the right course to be taken upon any particular case that arises, those whose duty it is having examined the papers, and the questions being submitted in a clear form to the President?—Just so.

68. Then, in order that this Commission may be informed who those persons are, at the Board of Trade, who prepare the statements upon which you come to a conclusion, you will, perhaps, be so kind as to tell us to whom certain letters arriving at the Board of Trade on the subject of lighthouses would be referred in the first instance, and the course they would take before the report upon them was finally completed for your information?—Upon any question

P. H. Berthon,
Esq.

29 Nov. 1860.

Mr. R. Allen.

Rt. Hon.
T. M. Gibson,
M.P.
T. H. Farrer,
Esq.

7 Dec. 1860.

*Rt. Hon.
T. M. Gibson,
M.P.
T. H. Farrer,
Esq.*

7 Dec. 1860.

of a lighthouse, Captain Sullivan, for instance, would draw up a memorandum, not binding upon the President, but for his information, so far as it goes; and Mr. Farrer or Mr. Booth, or both, would have an opportunity also in submitting Captain Sullivan's memorandum to the President to make any remark of his own; and also Mr. Williams, in a matter of account; and there would accompany those memoranda, the correspondence and papers relating generally to the subject, so as to form all that would be requisite to enable the President to come to a conclusion upon the question. In the case of the Scotch Lights there would be a correspondence between the Board of Trade and the Trinity House and the Northern Light Commissioners; and there would be memorials in many cases, probably the memorials of the Trade and Shipping interest, urging that any new light should be erected or alterations made; there would be various communications from the persons interested, and also professional opinions; and from these, taken together, there would be sufficient to enable the President to decide as to the course to be taken.

69. In order to exemplify more fully what the system is with which you have now been good enough to acquaint the Commissioners, might they be informed to whom the letter of the 23d of January 1855, on the subject of the Godrevy lighthouse, was first submitted by the Secretary of the Marine Department?—Not being President at the Board of Trade in 1855, I cannot give the information, but Mr. Farrer, the Assistant Secretary to the Board of Trade is here, and will give the information.

(*Mr. Farrer.*) I cannot charge my memory with it without referring to the papers. On doing so I see that this letter, after going into the registry room, was marked with Admiral Beechey's name, and went to him; it also has my name upon it; my name is put, as a matter of course, on all papers in the Marine Department; and this paper probably was taken by Admiral Beechey direct to Lord Stanley of Alderley, then our President. I see that the answer was, that it would be taken into favourable consideration. That minute is in Admiral Beechey's handwriting. I cannot charge myself with everything that passed, but I should mention that the papers do not show by any means all that passed, because here, as in every other case of business, the real business is often done by personal communication; and as this was a matter very much discussed, I know, although I was often not present, that there were many personal communications between Admiral Beechey, the Deputy Master of the Trinity House, and Lord Stanley of Alderley.

70. (*To Mr. Farrer.*) Will you be good enough to turn to the letter of the Board of Trade to the Trinity House, dated 12th of September 1855?—I have it here.

71. Can you state to the Commissioners by whom the report or submission was made upon which the order was given for that letter to be written?—This, I see, was sent to me in the first place; and I sent it in to Admiral Beechey, who seems to have written a long minute upon it, and who seems to have personally communicated with the Deputy Master, and also with the Hydrographer, for the purpose of getting the remarks of some Admiralty surveyor upon it; and, finally, a letter was written upon a minute in Admiral Beechey's handwriting; no doubt written by him, as his minutes constantly were, by the direction of the President, Lord Stanley of Alderley. There seems to have been a great deal of personal communication and consideration beforehand.

72. Have you got the paper upon which your letter of the 9th October 1856 was written?—Yes, I have it; a letter of the Trinity House, dated 13th of September.

73. Can you inform the Commissioners who gave the order for that letter to be written?—Yes. There appears to have been a legal question involved, and there is an opinion of mine upon it; there is then an opinion of Admiral Beechey, and also an opinion of Mr. Booth's.

74. Was it at any time a question of money or of

expenture. It is stated that they wished to be informed of the difference of expense; by whom in the department was it suggested that that question should be asked as to a difference of expense?—I speak somewhat in doubt, but as far as I can see from these papers it appears that the proposal of the Trinity House was one that would involve very considerably greater expense than had been originally contemplated by Admiral Beechey, and I see that I merely pointed out in my minute the legal position under the Statute which the Board of Trade and the Trinity House respectively held. Admiral Beechey had wished to have some further information as to the probable cost in case of its being placed upon one stone or upon the other stone, and consequently upon that suggestion this letter of ours of the 13th September 1856 was written asking the question.

75. (*To Mr. Milner Gibson.*) Has it been necessary to increase the clerical staff of the Marine Department of the Board of Trade to any considerable extent in consequence of the lighthouse business alone?—There has been no increase of the staff since I have been at the Board of Trade, that I am aware of, on account of the pressure of that business. There is of course a good deal of business in the Marine Department.

76. But you think not with reference particularly to the lighthouse business?

(*Mr. Farrer.*) The clerical business of the Marine Department is constantly growing. No doubt there have been additions, but I am not aware of any specific additions lately on account of that. There were at the time when the Merchant Shipping Act was passed, or rather when the Act of 1853 was passed.

(*Mr. Milner Gibson.*) I may just observe that soon after the passing of the Merchant Shipping Act of course there would be many novelties to deal with, and difficulties to encounter, that do not arise now that matters have got into a state of routine. Difficulties at first existed which are not so great now.

77. We have found during our enquiry that lighthouse illumination is a complicated subject, which has occupied much of the attention of scientific men; is there any officer of the Board of Trade who is practically acquainted with those sciences which enter into the construction and use of illuminating apparatus, such as optics, glass manufacture, combustion, ventilation, the best forms of vessels for floating lights, and the forms of buoys and beacons?—The Trinity House has the advantage of the advice of Professor Faraday, who is a very eminent scientific man, and thoroughly acquainted, I should think, with the chemical part of the question as it relates to illuminating; and they have the benefit of their engineer, Mr. Walker. It cannot be said of the Board of Trade that they have there a person specially appointed as a chemist, or specially appointed as an optician. I may mention that Professor Faraday does the work for the Board of Trade for the Colonial lighthouses; the Trinity House, as regards the lighthouses in England, take his advice; there are separate boards for Ireland and Scotland; but still the Trinity Corporation has a certain authority, and Professor Faraday's advice is, of course, always to be had by the Trinity House, and he is their chemical and scientific adviser upon illuminating questions and lights.

(*Mr. Farrer.*) He has also advised the Trinity House upon the optical part of the business.

(*Mr. Milner Gibson.*) The Commissioners must bear in mind that we at the Board of Trade have the advantage of the information which is obtained by all these different bodies from their scientific advisers, because it may centre there; and if any question in dispute has to be decided we have the benefit of all the correspondence and all the professional opinions that have been given. With regard to the forms of Buoys and Beacons, that, as I suppose, has reference to what is the best thing to be seen at sea; and that is a matter that a sailor, who is in the habit of looking out for such things, would be the best judge of, I think. What are the easiest colours to discern, and the easiest forms to see, at a distance?—I think that we have an opportunity of forming an opinion upon

such questions as those ; at least, we have the best advice, and we have the opinions before us of most competent men ; we may have the advice of Mr. Stevenson, a very eminent man in Scotland, and Professor Faraday, and Mr. Walker, according to the different questions that may arise. Upon purely nautical questions, of course we have nautical opinions.

78. You say you have nautical opinions ?—Yes ; we have in the Board of Trade itself ; but we are not bound by them, because we may have before us the nautical opinions of the Trinity House.

79. You mean therefore the nautical opinions of the Trinity House, the Lighthouse Authorities, as well as of those officers who are in your own department ?—Just so ; the President for the time being, if he chooses to avail himself of all the information within his reach upon any question of this character, has the means of coming to a sound decision upon it.

80. With respect to those means, are they such as you have already enumerated, or do you refer particularly to means actually within the office, and which have not been alluded to in your previous answers ?—I speak of the means which are within the office, and also of the means which are out of the office, because the means in the office—the memoranda drawn up by those who are in the office—would be but the opinions of gentlemen in the office, and not binding upon the President ; he might, comparing those opinions with other professional opinions, perhaps differ from those in the office ; he is bound to come to his decision upon all the information before him, I conceive, and these memoranda are drawn up there for the guidance and information of the President, but not to bind him.

81. Are the Commissioners to understand that you have no persons in the office besides those that are enumerated in the official lists who have special means of making themselves acquainted with the subject of lighthouse illumination, or who have studied the subject either before or since the passing of the Merchant Shipping Act ?—No, not that I am aware of, not in the office ; no person that can be regarded as specially so employed. When you speak of lighthouse illumination there are so many branches of it ; do you mean the chemical branch ?

82. I would say both optical and chemical.—On these points we have the advice of Professor Faraday through the Trinity House.

(*Mr. Farrer.*) And also with respect to Colonial lighthouses we have his advice direct.

(*Mr. Milner Gibson.*) Our control, in point of fact, is the control of the purse. We have ultimately to decide whether any proposed expenditure to be charged upon the Mercantile Marine Fund is to be undertaken or not ; whether upon the whole, viewing the thing in all its bearings, it is desirable that the proposed expenditure should take place or not.

83. I do not know whether you have had occasion to look at the Reports of the various Select Committees which, since 1822, have been appointed by Parliament to inquire into the management of the lighthouses of this kingdom. If you have done so, and have seen the Report of the Committee of 1834, I would ask whether, as a principle, you concur in the opinion of that Committee as to “the paramount necessity of having the best lighthouses and floating light establishments for this great naval and commercial country which the state of science can afford ?”—My opinion is that every lighthouse or floating light should be as good as science can make it, in order to answer the purpose for which it was intended. For instance, although a particular light might not be the brightest or the best in existence, still if it answered the purpose for which that particular light was intended, I should not think it necessary, therefore, because it was inferior to what might exist, to go to the expense of altering it. The question that I should consider would be this : Is the light as good as it need be for the particular purpose ? If it were a first-class light then I have no doubt that it ought to be as good as science could make it ;

but if it were one that need not be seen for so great a distance, or not of so important a character, it might answer the purpose for which it was intended, although perhaps not altogether as good as science could make it. Of course we must bear in mind that we have expenditure to consider, and that these lights being a charge upon the trade and merchant shipping of the country, unnecessary expenditure ought not to be incurred. The cost necessary to make things as good as they ought to be made must be incurred, but unnecessary expenditure it is our duty to avoid.

84. You have just stated that you are of opinion that the lighthouses should be the best that science can afford to make them, in order to answer the particular purpose for which they are intended, but that it is above all things essential for the Board of Trade to consider what expense is necessary or unnecessary, as the case may be, in order that the lights shall be the best that science can afford, and fit for the particular purpose. Do you feel satisfied that you have, in the office of the Board of Trade, the means of coming to a satisfactory conclusion, in your own mind, as to what is really necessary and unnecessary in the way of expense ?—I think that we have great aids in the Board of Trade, which, in conjunction with the information we get from the Trinity House, and the Northern Light Commissioners, and the Ballast Board in Ireland, is quite sufficient to enable the President to come to a conclusion upon any particular point of that sort.

85. Then perhaps you would admit, that in the process of coming to such a conclusion considerable time must be occupied, and a considerable amount of business and clerical work gone through, not having the necessary machinery exactly in your own department ?—We have a good deal of machinery in our own department ; but of course you cannot lay down any general rule, as applicable to every question upon which there may be some difference of opinion. Some are simple questions, some are complicated ; some are trifling in importance, and others are of very great importance ; therefore, of course, the consideration to be given to them, and the trouble that is taken must have some relation to the character of the questions themselves. I may state this, that Professor Faraday and Mr. Stevenson have been from time to time in personal communication with the Board of Trade ; and it is not necessary, in order to have their advice on all occasions, to go through a correspondence. Upon a recent occasion, a question arising as to a change in the mode of illuminating the Dungeness Lighthouse, I had a personal conference with Professor Faraday, in order to hear from him what his opinions were as to the scheme proposed.

86. May I ask whether, in your communications on that subject with Professor Faraday, that part of the question was gone into which relates to the eligibility of the particular site of Dungeness for the exhibition of the light proposed to be shown there ?—Upon that point, which is nautical, I should have the benefit of the advice of Captain Sullivan ; I should also have the benefit of the advice of the Trinity House ; they would give opinions as to the character of the light which, in point of brightness, ought to be exhibited from Dungeness, and the height and position of the lighthouse at Dungeness. Then Professor Faraday, who is an eminent chemist, would give his opinion as to whether the proposed plan was likely to produce that intensity of light which the nautical authorities said was desirable for that site.

87. My question was rather to ascertain whether the one particular subject of eligibility of position for the exhibition of the electric light at Dungeness actually came under discussion in your communications with Professor Faraday ?—It was understood that the brilliancy of the Dungeness light ought to be increased ; that as it is a light of great importance to ships coming up channel, and as it must necessarily stand on low ground, and in a climate subject to thick weather, it was thought very important that any

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rate the light should be able to penetrate through a thick atmosphere as far as possible, and to be visible at all times as far as possible. Having to improve Dungeness light, it was thought that perhaps the electric light, as being of greater brilliancy, would be applied there with advantage; and Professor Faraday was consulted mainly upon the plan of the electric light; whether it had been already sufficiently tested to justify the expenditure proposed to be incurred by adopting it at Dungeness, and whether, in his opinion, it would answer the purpose proposed.

88. Are the Commissioners, therefore, to understand that the question of the fitness of the site of Dungeness for a further trial, as well as the exhibition of the electric light, did come under discussion in your communications with Professor Faraday?—I would answer that question by saying that the adoption of the electric light for the present at Dungeness may be considered in some measure a further trial, and in pursuance of experiments that had already been made, but which we should not have adopted unless the trial which the electric light had already received elsewhere had given such confidence in it as to justify this further trial.

89. You think it probable that the question of Dungeness as to the position of the light did embrace the two points, both of site for trial, and as presenting a good opportunity for exhibiting a bright light where a bright light was needed?—Yes. I never heard that it was an improper site for the trial. Nothing was said against it as a site for the trial; but the main point dwelt upon was that it was very important that at Dungeness you should have a light of great brilliancy that could penetrate a thick foggy atmosphere as far as possible, inasmuch as it was low ground, and vessels would be drawing in. The brilliancy of the light has a good deal to do with its being seen in a hazy atmosphere; you have many fogs as you approach the narrows hanging about the low ground of Dungeness and the Romney marshes. It is very important, therefore, that you should have a light that can penetrate a thick atmosphere. I should perhaps add, that at the time this question arose the Start Lighthouse, as well as Dungeness, required a new lighting apparatus, and that the expediency of trying the new electric light at the Start was considered. In some respects, *e.g.*, height and land fall, the Start would have been preferable. But the question was decided in favour of Dungeness by Professor Faraday's opinion, that the electric light should at present be tried in a fixed light and not in a revolving light, which the one at the Start must be.

90. I think you have stated that the Board of Trade has ample means of coming to a decision upon various matters that may be called scientific, from being able to refer to scientific authorities, as they now exist in the several Lighthouse Boards; but supposing the Board of Trade to differ from any of the recommendations of the Executive Boards on nautical engineering or scientific matters, what would be the course that you would then adopt before forming an opinion which might differ in nature and degree from that of any of the Executive Boards?—We are not the managing Executive of the Lighthouse system; we do not profess to be that; we do not act in that spirit. The powers which are vested in the Board of Trade by Act of Parliament were for the purpose mainly of controlling the expenditure, and of preventing unnecessary expenditure; and when any plan is submitted to us, we, of course, before we sanction it, satisfy ourselves that it is a necessary and judicious

expenditure, that the professional advice and the scientific opinions are of a character to justify it, and that the plans are in conformity with the best professional opinions. It is a very difficult thing exactly to define what is the power of the controlling body that is said to hold the purse-strings; it is difficult to draw the line exactly beyond which it must not go; but the view that I take of it, having looked at the Act of Parliament, is simply this, that we are to decide whether any proposed expenditure, on the whole, ought to be undertaken or not. That is what we have to decide, and we must get all the information that bears upon that to enable us to come to a decision. With reference to the other part of the question, I may state, that since I have been at the Board of Trade we have had no differences with the Trinity House; at any rate, I do not recollect anything but small matters. With the Northern Light Commissioners there have been some differences. There was a disagreement between the Northern Light Commissioners and the Trinity House as to the character of the Rhu Vall Light,—as to its site, I believe,—and the Board of Trade agreed with the Trinity House. We consider that we have got the means of deciding nautical questions, or of forming a very good opinion upon them, in the Board of Trade itself.

91. (*To Mr. Farrer.*) It appears that a letter was written on the 4th of November 1856, to the Department of the Secretary for War, on the subject of the erection of a Lighthouse on St. Ives Point. Can you inform the Commissioners by whom the order for the writing of that letter was given?—It was written upon the minute of Admiral Beechey,—I see that it has his initials,—after a communication with Lord Stanley of Alderley, and some communication with Mr. Williams about money. I should mention that sometimes the President's own minute or initials appear on our papers; sometimes any of us, as it may happen, takes the papers in to him, and receives his directions, and we make a note of them ourselves.

92. Then, in answer to a letter from the Trinity House to the Board of Trade, of the 4th February 1857, a letter was written on the 12th of February 1857 in reply. Can you inform the Commissioners by whose orders that letter was written?—It was written by the direction of Lord Stanley of Alderley, after a communication with Captain Sullivan and myself. When I say that this was done I only tell you what I see happened by our own minute papers; it is quite possible that many other communications may have taken place which are not noted on our minute papers.

93. A letter was also written on the 9th of March 1857 by the Board of Trade to the Secretary of the Trinity House, on the subject of the Godrevy lighthouse. Can you inform the Commissioners by whose order that letter was written?—That was written by the direction of Lord Stanley of Alderley, upon a minute by Captain Sullivan.

94. (*Captain Ryder.*) What is the course adopted with letters arriving at the Board of Trade on the subject of lights, buoys, and beacons in the colonies, previously to a decision being come to by the Lords Commissioners of the Privy Council for Trade?—The course adopted is precisely the same as in the case of the English lighthouses, so far as the routine of the office is concerned. Of course the circumstances differ much. And the mode of obtaining advice from engineers or other persons out of the office differs from the mode of obtaining it where we have Executive Lighthouse Boards to deal with.

Adjourned till Tuesday next, at 12 o'clock.

Tuesday, 11th December, 1860.

PRESENT :

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON, R.N.
Captain ALFRED PHILIPS RYDER, R.N.
JOHN HALL GLADSTONE, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

SIR JAMES DOMBRIN, examined.

95. (*Chairman.*) You are one of the members of the Corporation of the Ballast Board of Dublin?—Yes.

96. You were formerly an officer in the Royal Navy, and commanded the Coast Guard in Ireland?—Yes. I established the Coast Guard in Ireland in the year 1819, and commanded it for 30 years, and my duties of inspector led me to visit every Coast Guard station at least once every year, and frequently much oftener. By those duties, frequently performed afloat, I became thoroughly acquainted with the whole coast, and since that period, namely, when I left the Coast Guard, I have, as a member of the Ballast Board, attended every inspection but one, as a member of the Inspecting Committee.

97. How long have you been a member of the Ballast Board of Dublin?—I think I have been a member of the Board for nearly fourteen years. I think it was in 1847 that I became a member.

98. Two of the Committees of that Corporation seem to be appropriated to lighthouse duties, namely, the "Lightship Committee," and the "Inspecting Committee"?—It is one Committee, namely, Inspecting Committee, who visit and inspect both lighthouses and lightships.

99. During the whole of those fourteen years have you been employed generally upon matters concerning the lighthouses of Ireland?—Yes; but the inspection of the lighthouses did not commence till a few years after I had been appointed one of the Board. There had not been any previous inspection by Committees of the Board, I believe, for a number of years, but after joining the Board I saw the great importance of the Commissioners themselves becoming acquainted with their establishments on the coast, and I was one of those who very strongly urged upon the Board the necessity of getting a steamer for the purpose of making those inspections. I think it was in 1852.

100. Are the Commissioners to understand that there was no regular system of inspection antecedent to the period when you made that suggestion?—None; but the inspections were carried on by Mr. Halpin, who duly reported his proceedings to the Board.

101. Who was Mr. Halpin?—He was called, I think, inspector and engineer.

102. Had he anything to do with the actual construction, either of the lighthouses or the illuminating apparatus?—He had everything to do with the construction of lighthouses, and the mode of lighting them, as a great number were built entirely under his management and under his direction and at his suggestion.

103. What part was he required to take with respect to the ordering of the illuminating apparatus?—The truth, I believe, is that it was left entirely to Mr. Halpin's recommendation, of course under the sanction and approval of the Board, but he was the originator of all the works that were required for the lighthouse establishments.

104. Then who is the present engineer?—Mr. Halpin, the son of the late Mr. Halpin, is the Superintendent, under the denomination given him by the Board of Trade.

105. Who is the inspector?—He is of the lighthouse establishments, and Captain Roberts of lightships and buoys. Mr. Halpin's denomination is now "Superintendent."

106. Should you say that, in practice, there was any disadvantage in the circumstance of having the person who constructs or directs the construction and the person who inspects one and the same?—My own impression always has been, and I have never con-

cealed it from the Board, but at all times, and on all occasions, when on inspection, or otherwise, that the Inspector and the Engineer ought to be two separate and distinct persons. I think, in principle, that the person who constructs, directs, and certifies should not be the inspector of his own work; and further, that as all applications for lighthouses, buoys, and beacons are based on nautical grounds, that the inspector should be a naval officer.

107. Can you state what the instructions are under which the Inspector now makes his visits, or who gives the instructions?—Indeed, it has been left hitherto, I think, to himself, to inspect when he could; but his duties are so numerous that I am afraid I could not report that any general inspection has been undertaken by the present Superintendent, except when he has accompanied the Inspecting Committees.

108. You have just stated that his duties are "so numerous," can you at all describe to the Commissioners what those duties are?—He holds the situation not only of Superintendent and Engineer and Inspector of Lighthouses but he is also Engineer of the Port, under the Port of Dublin Corporation, and those duties have been onerous, and very heavy upon him; but the Board have lately taken means to relieve him from a great portion of the Port duties, in order to enable him to devote his attention more to the Lighthouse Department.

109. Is he the regularly salaried Engineer of the Port of Dublin Corporation?—His salary is paid partly from the Marine Fund, and partly from the Port Fund.

110. Can you separate the proportions?—I think two thirds are paid by the Board of Trade out of the Mercantile Marine Fund, and one third by the Port, amounting all together very closely to 1,000*l.* a year now.

111. (*Mr. Gladstone.*) It appears that the salary is 800*l.*, and that there is an allowance of 100*l.* for a residence?—Yes; I think it is 800*l.*, which increases year by year, I think, to 920*l.*, or something like that.

112. (*Chairman.*) Is it exclusively for his duties as connected with the Lighthouse service of the Ballast Board that he receives this salary out of the Mercantile Marine Fund?—Yes, he receives two thirds from the Mercantile Marine Fund, and one third from the Port.

113. Are the two thirds from the Mercantile Marine Fund in virtue of his office as Superintendent of the Lighthouse Board?—Certainly, as Superintendent and Engineer.

114. (*Captain Ryder.*) Are the Commissioners to understand that the Superintendent has no special instructions with regard to his inspections, and that he does not inspect regularly?—He has no special instructions, but occasionally he has instructions to inspect any particular station that may require his attendance, or report upon any matter specially referred to him.

115. (*Chairman.*) Can you furnish the Commissioners with the Inspector's last Annual Report of his visits?—I am afraid that there is not any Annual Report from the Inspector.

116. What should you say was the average time that elapses between the Inspector's visits to the Lighthouses?—He has accompanied, for the last seven or eight years, the Committees of Inspection, in all cases, and those have been his inspections, when accompanying the Committees, but he has not made any general inspection at any other time.

117. Should you say those inspections of the Committee were annual and regular?—Certainly, from

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the time they first commenced they have been exceedingly so, and more than annual, sometimes they have been twice in a year.

118. (*Captain Ryder.*) What is the longest time that has elapsed between the visits of the Superintendent to any particular lighthouse?—I cannot exactly charge my memory with those which have not been inspected, from the inability of the Committee to communicate with particular lighthouses on the coast, it may have been in some cases two or three years; but all the principal lighthouses, with one or two exceptions, have been inspected annually, and these exceptions have been accounted for by the state of the weather.

119. Some of those lighthouses which have not been visited on account of the weather might have been visited, might they not, by the Inspector from the shore?—Undoubtedly they may have been, if he could have found time to have done it.

120. (*Chairman.*) Can you state the method of ordering the annual supply of stores, including the requisitions, &c., showing at what step the documents are submitted to the Ballast Board; or could you produce the last year's requisition for stores?—There is no requisition to the Board whatever, exclusive of oil, and the supply of all stores has rested hitherto with the Superintendent. I took the trouble, lately, to inquire from Mr. Halpin upon what principle furniture and various articles, for the use of the Light Keepers, were supplied, whether there was any fixed rule as to the quantity or not, and he stated to me that it was quite arbitrary with himself to order what he thought necessary for them; and upon ascertaining this, I drew out and submitted a form to the Board, and which has been ordered to be adopted.

121. You have stated that the supply of all stores rests with the Superintendent?—Yes.

122. Can you give the Commissioners a description of the requisition upon which he orders the stores to be supplied?—It is on application from the Light Keepers, stating to him what is required to replace either that which has been worn out or become defective from other causes.

123. (*Captain Ryder.*) Or anything that may be required in addition?—Yes.

124. (*Chairman.*) Is that application from the Light Keepers made upon any tabulated paper or printed form?—I believe it is to the Superintendent.

125. Then, in time, is not that submitted to the Ballast Board?—No; the accounts of the cost of all these articles, of course, all pass through the Board; and in future, as I have already stated, the Board will have these requisitions before them; the articles are generally supplied by contract. Annual tenders are called for for the supply of certain articles, such as brushes, brooms, and various things of that kind which are required by the Light Keepers; it is always done by public advertisement.

126. Can you produce the last year's report of the stock remaining in hand, the document actually presented to the Board with the minutes upon it?—I cannot do so, for, as already stated, the system is not yet in operation.

127. (*Captain Ryder.*) Is there such a thing?—I apprehend Mr. Halpin has some such returns at present, and that he can furnish the Commissioners with them when he is called upon to do so.

128. Has he produced such a document to the Ballast Board as to the stock remaining in hand?—Whenever it is called for, on any particular occasion, a return is immediately produced by Mr. Halpin, but not so clear and comprehensive as the one now approved by the Board.

129. (*Chairman.*) I believe you are one of the Visiting Committee?—Yes.

130. As one of that committee, can you produce the last general account of the state of the fabrics and illuminating apparatus, &c., showing the repairs that were necessary?—I can produce the minute book of the inspections, which will show the Commissioners

the duties performed by the Inspecting Committee, at each Lighthouse establishment, on the coast. Their observations are always directed to the state of the buildings and the state of the apparatus, the repairs necessary, and in fact the general state of everything, houses and everything else. I have the minute book of inspection with me if the Commissioners wish to see it. I brought it for our own reference, in case the Commissioners should ask any question connected with it.

131. Can you state the course which is adopted in each case for making the required repairs, showing the time that elapses from the date of the requisition until the repairs are taken in hand?—I cannot do that. Mr. Halpin could supply the Commissioners with that information.

132. (*Captain Ryder.*) Do you know the course that is generally adopted with regard to local affairs?—Yes.

133. What is the course taken?—We have been very anxious indeed,—that is, the Inspecting Committee,—on all occasions, to endeavour to get the small work that is required, such as painting and small repairs, done by some local parties. It has hitherto been the practice, on the part of the Superintendent, to send mechanics and artisans from Dublin to execute those repairs, to do painting and things of that nature, which we thought ought and could be done much more economically, and probably just as well upon the spot; we have very strongly urged it, and pressed it upon Mr. Halpin to do so, and I believe in a great number of cases he has adopted our views; but there are some parts to which it is necessary to send persons from Dublin, for instance, anything connected with the apparatus—lamps or anything of that kind—we are obliged to send a proper lamp fitter from Dublin, we could not find a person of that kind on the spot; but in all other matters, in small repairs, we have urged it very strongly on all occasions that they should, if possible, be done by local tradesmen.

134. (*Chairman.*) You say that it has been the habit of the Superintendent to send persons from Dublin to execute ordinary repairs, excepting those you have mentioned?—I think principally for painting and repairs of lamps, and things of that kind.

135. With the exception of matters which related to the illuminating apparatus persons might have been employed on the spot?—Yes.

136. Should you say that that had been the practice, with respect to Lighthouses, at whatever distance from Dublin?—The practice has hitherto been to send persons from Dublin, but latterly that has been discontinued to some extent.

137. You have already stated that you strongly recommended that a new system should be adopted, and that parties on the spot should be invited to undertake what was required to be done?—Yes; and I know that in some cases that has been carried out.

138. (*Captain Ryder.*) In many of the replies which you have given, you have spoken of the Superintendent being urged to do this and pressed to do that. I wish to know how it is that he does not obey the orders which, I understand by those expressions are given to him by the Committee on Lighthouses?—I have already stated that Mr. Halpin's duties are very heavy. In addition to that his state of health is not good. He is now laid up, and has been ordered, I believe, not to attend to any work whatever for three months. Mr. Halpin, I believe, is a very zealous and very anxious man, but he troubles himself too much in the details of the establishment without, in my mind, looking to the main features of it; that is, if the smallest account comes before him he thinks it necessary that he should go through that account and make his report upon it, whereas it is one of those ordinary returns such as may come, by a printed form, from a Lightkeeper, and he thinks it necessary that he should go into the details of that himself instead of intrusting it to the people in his office, thereby occupying a great deal of his time, in my opinion, unnecessarily.

It has been very much urged upon him by the Board that he should endeavour to make a different arrangement, so as to be able to devote more of his time to the principal part of his duties. The Board have, as I stated before, relieved him from a great deal of his port duties, and have told him now that they will require that he shall make at least one annual inspection of all the Lighthouses on the coast, irrespective altogether of the proceedings of the Inspecting Committee.

139. (*Mr. Gladstone.*) Do not the Secretaries of the Ballast Board relieve him of some of the duties you have just mentioned?—The Board have, within the last few months, ordered that in future all correspondence connected with the establishment should be addressed to the Secretary, and by that they hoped to be enabled to see what Mr. Halpin really had to do, and, as far as possible, to relieve him from the very minute details which he has hitherto thought it necessary to go into.

140. (*Chairman.*) Then to whom had that correspondence been addressed previously to its being ordered to go to the Secretaries?—To Mr. Halpin.

141. I presume that the official correspondence from the Board of Trade was not addressed to Mr. Halpin?—No, it was not. I am speaking of the establishment which is considered under Mr. Halpin's superintendence, as Superintendent of Lighthouses and Engineer.

142. You stated that you had brought with you the minute book of the inspections—can you produce the last report of Captain Roberts, of his inspections?—No; I have not got the last report of his inspection, although I have the report of the Committee of Inspection on both lighthouses and lightships.

143. (*Captain Ryder.*) Is Captain Roberts's report a full one?—He reports on all occasions after inspection, and also whenever any matter arises necessary for the Board to be informed of, and I may take the opportunity now of saying that a more anxious or zealous man I do not know, and he discharges his duty to the perfect satisfaction of every member of the Board.

144. (*Chairman.*) I take for granted that you know the *Midge*, the present buoy boat of the Ballast Board?—Yes.

145. As a person accustomed to the sea, do you consider the "*Midge*" a fit vessel for the duties she has to perform?—I consider her a most dangerous vessel, and wholly unsuited for the purpose for which she was intended. Only within the last fortnight she had to take out a light ship to replace another, merely as far as the "*Kish*," and she could not accomplish it; she was obliged to come back; it was only blowing moderately strong, but she could not accomplish it.

146. Was it ever contemplated, in supplying the "*Midge*," that she was to undertake the duties of replacing a light vessel?—Certainly.

147. Do you think that the Board of Trade was aware that she was expected to perform that duty?—She was built under the orders of the Board of Trade, and it was very strongly urged upon them to have a vessel sufficiently large to enable her to do that duty to a certainty—at all times to be enabled to do it; but the President of the Board of Trade, at the time, limited the expense to a certain sum; he would not allow a few hundreds more to have a proper vessel, and hence the unfortunate craft that we have got.

148. Was it subsequently to the sale of the "*Argus*" that this vessel was intended by the Board of Trade to perform the duty of shifting a light ship?—Yes. I should state that when the "*Argus*" was dispensed with in Ireland, the arrangement under which it was done was, that we were, at any time that we required it, to have a steamer belonging to the Trinity Board stationed at Milford, for the purpose either of shifting light ships or any other purpose that we might actually require; but in our applications to the Trinity Board, we have found that it has often been attended with the most serious inconvenience to them to give us a vessel, even for our

inspection, and therefore we have not applied to them to shift a light ship, for we knew, from our communications with them, that it has only been at great inconvenience to their department that they have given a vessel upon almost any occasion, and upon our last application, I think about August, they were compelled to refuse one.

149. What was the date when the "*Midge*" was employed to shift the "*Kish*" light ship, as you have mentioned?—I think about a fortnight ago.

150. Had you applied to the Trinity House in the first instance?—No, not for that, because the distance was so very short; the distance was only seven or eight miles.

151. (*Captain Ryder.*) How did you shift the "*Kish*" light vessel?—We shifted her at last by the "*Midge*," but with a great deal of trouble.

152. (*Mr. Gladstone.*) And loss of time?—Yes; perhaps I may observe here, that when that vessel gets two heavy buoys on her deck, it is positively dangerous for her to go to sea.

153. (*Chairman.*) Do you remember that an arrangement was entered into with the City of Dublin Steam Packet Company to replace light vessels if required to do so, and can you state whether the arrangements were made by the Ballast Board or by the Board of Trade?—I think there was one occasion—I cannot exactly charge my memory with it—on which an application was made to the City of Dublin Company, by the Ballast Board, for the hire of a vessel to shift one of our light ships, for which I think they were paid 120*l.* I am not quite sure, but I think that was the case; but no general arrangements have been ever entered into with them, although we were permitted to make such an arrangement by the Board of Trade if we could do so.

154. Are you aware of any reasons for the arrangement not being carried out?—The City of Dublin Company stated that they could not be answerable for supplying a vessel when we might require it, at a short notice; that their vessels were engaged in the trade and commerce of the Port, and that they could not take them off their lines for the purpose of shifting light vessels.

155. I perceive, in answer to our question 9, with respect to the mode of selecting and appointing officers, that the appointments of the Ballast Board are subject to the approval of the Lord Lieutenant and the Board of Trade; has the power of disapproval ever been expressed by the Board of Trade, or by the Lord Lieutenant?—Never, I believe.

156. It would appear, at first sight, that the Ballast Board was subject to the jurisdiction of the Trinity House, and to a certain extent of the Board of Trade?—Precisely so.

157. But it appears that there is also another jurisdiction that enters into the Government, viz., that of the Lord Lieutenant?—Yes.

158. Then the Lighthouse system in Ireland may be said to have a quadruple government—its own Board, the Trinity House, the Board of Trade, and the Lord Lieutenant?—That of the Lord Lieutenant is merely as to the confirmation of appointments, or the disapproval of them; it enters in no part into the general management of the establishments in any way—it is merely that if you propose the appointment of a new officer, or an increase of salary, according to the Act under which the Board is constituted, you must submit it to the Lord Lieutenant, and, if he does not disapprove of it, I think in 21 days, then the appointment may take place.

159. But his approval or disapproval applies to officers of every description, does it not?—Not to Light Keepers.

160. But to the salaried officers?—Merely to the salaried officers under the Board.

161. (*Mr. Gladstone.*) And as to making any rule, order, or regulation?—Yes; there are certain regulations for the government of the Port, not as a lighthouse establishment—there are regulations such as for the quays and matters of that kind; for

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instance, at this moment the Board have under their anxious consideration regulations for the government of the quays, which may be termed Harbour Regulations; those, when they are properly digested and considered will be submitted to the Lord Lieutenant for his approval—indeed, I believe that they are already, probably since I left, or they were to have been—but nothing connected with the Lighthouse whatever, it is merely the Port.

162. Do you think that the Act of Parliament merely relates to the Port in that instance?—Yes. All the officers in the establishment, the Commissioners will observe, are paid part Port Fund and part Lighthouse Fund, excepting Captain Roberts—he is on the Lighthouse Fund solely.

163. (*Chairman*.) Can you state how the power given to the Board of Trade by the Merchant Shipping Act, in Sections 422 and 423, to control expenditure, is exercised?—It is exercised by the Board of Trade in this manner:—Our expenditure is controlled by annual estimates; the annual estimates are submitted to the Board of Trade, showing what is required for everything connected with the establishment, as far of course as human foresight can give it, down to the minutest particulars; it is then sent forward to the Board of Trade, and they state whether they approve of those general estimates or not. But they have given us an order also that, even as to those which they approve, if it be any extensive or new work, that it shall not be carried into execution by the Board, although the Estimate may have been approved by them, until the subject of that particular work—if it be, as I have stated, of an extensive character—is again brought under their notice; and all cases which may arise incidentally—that is, any damage that may occur that could not be foreseen—is then to be submitted to the Board of Trade, and they give their authority upon it or not, as they think proper.

164. (*Chairman*.) Then no fund is allowed to you for incidental expenses?—Not a shilling. I will mention an instance. The Annual Estimates provided a sum, I think, amounting to 3,700*l.*; it was for the alteration of three lights on the coast, from catoptric to dioptric: they approved of the annual estimates in the gross, but when we applied to them to make this alteration at one or two particular lights, which we thought of very great importance to have made dioptric, they refused it.

165. Did the Board give their reasons for not allowing it?—Yes; and their reasons were that until the old catoptric reflectors were worn out they would not sanction an alteration. In our recommendation we selected three of the most important stations, as we thought, upon the coast; the first was Cork Harbour, which has a bad light, and yet it is a very

important light at Roche's Point, which is seen at a very short distance. Then there is Copeland Island at the entrance to Belfast Lough, and Tory Island, which is generally first made by vessels coming north about.

166. (*Captain Ryder*.) How long will the reflectors at those three lighthouses, in your opinion, last? First, take Roche's Point in Cork Harbour?—Generally, I think, they may last for nine or ten years, affording a diminished light every year. At Cork, on a very recent occasion, the owners of one of the Atlantic steamers reported to the Ballast Board that on a certain night, when within five or six miles of the land, the light at Roche's Point was not distinguishable, and they attributed this, in their report, to the neglect of the light keeper, who they said could not have had the lamps lighted at the time; but an inquiry was immediately instituted by the Ballast Board, when they found that the light had been duly exhibited, but its power is so circumscribed that it was not seen at that distance. It was represented to the Ballast Board also by the Admiral at Cove, and the Admiral urged upon us the placing of a better light there, but which was refused by the Board of Trade, it being one of the places that we had long previously recommended on our tours of inspection. We looked at it in this light—that Cork and Belfast were the two principal ports in Ireland, and that to those we would apply the better light as soon as we could, the Tory Island light being the light which is generally made by vessels coming from America, we considered of equal importance.

167. Are there any other catoptric lights which the Ballast Board would wish to change as soon as possible to dioptric lights?—Yes; I am quite sure that they would change the whole, because before the Board were put under the control of the Board of Trade it was part of their arrangement that as the others became worn out, or any circumstances arose to render it desirable that the better light should be exhibited, it should be taken in hand, and annually some should be changed.

168. Then are the Commissioners to understand that if the Ballast Board had retained the management of its own pecuniary affairs there would have been a much larger number of dioptric lights in Ireland than there are at present?—I can have no question about it, provided the Trinity Board concurred with us, which I am very happy to say they have done on all occasions. There has never been any difference of opinion between us, and we find them most anxious to meet our views and wishes in every respect. We have really found them very obliging on all occasions.

The Right Honourable the EARL OF MEATH examined.

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169. (*Chairman*.) You are one of the members of the Ballast Board of Dublin?—I am.

170. How long have you been a member of that Board?—I think about eight years.

171. You were chairman, I believe, of the visiting committee of 1859?—I was.

172. Can you state to the Commissioners what the views of the Ballast Board are with regard to the adoption of a uniform system of buoyage, both as to the best colours for buoys, as well as the system under which the buoys should be placed?—The opinion of the Ballast Board is that a uniform system of buoyage should be adopted throughout the United Kingdom.

173. Then at present no regular system of buoyage does exist in Ireland?—None.

174. Can you state whether the suggestions as to the colouring of the buoys in particular localities have been made by the Ballast Board to the Board of Trade, and whether the suggestions of the Ballast Board have been adopted or not?—Suggestions have been made by the Ballast Board with a view of carrying out a uniform system round the Irish coasts, but without success. Captain Roberts, seeing the very great difficulties and dangers incurred by masters of

vessels navigating along our shores from the different systems of buoying that exist in different localities, recommended our Board to adopt, throughout the entire of their jurisdiction, the simple plan of painting all buoys red on the starboard hand and black on the port in entering harbours, rivers, and channels, and that chequered buoys should mark all middle dangers. This plan was approved of by our Board, but, on being placed before the Elder Brethren for their consideration, it failed to obtain their approval, and therefore could not be put into execution. I may add that this plan has been adopted for some time by the Commissioners of Northern Lights, as also by the Belfast and Derry Harbour Commissioners, and if we had been allowed to adopt it the system would have become general in the Irish Channel. As to the colours of buoys, I believe that all practical men are of opinion that red and black are best seen in our waters. Suggestions have been made by the Ballast Board.

175. Some of the buoys on the coast of Ireland, I believe, have been placed there by the Admiralty; can you state in what localities buoys have been so placed by the Admiralty?—I know of a certain number of Admiralty buoys, but I could not go over the list of them without refreshing my memory.

176. Do you remember the circumstances attending an application from the Admiralty Board to the Ballast Board to place buoys at Berehaven?—I do, perfectly. For correctness sake I would refer the Commissioners to the correspondence from the Ballast Board, which has been given in our answers to questions 17 and 18, Circular 5.

177. It appears, from that correspondence to which you have referred, that the Admiralty declined to take any share in the expense of laying down those buoys, and that in consequence the Board of Trade refused to sanction any expense on the part of the Ballast Board for the same purpose. Would the placing of those buoys in that locality have been of use to the merchant shipping and to the trade generally?—Most undoubtedly it would to the trade in general of the kingdom. These useful buoys have not been placed in consequence of the Board of Trade refusing to adopt them, as the Admiralty could not sanction the expenditure of two-thirds of the cost.

178. (*Captain Ryder.*) Then, because men of war frequent the harbours on the coast of Ireland, the merchant shipping is deprived of buoys?—Such appear to be the views of the Board of Trade, indeed, I am sorry to say, that on all subjects referred to them they invariably seem to be guided in their decisions by that wretched low principle of economy, and not by the consideration of what amount of public benefit is likely to accrue from the execution of the public works submitted to them for their approval. I look upon that board as a sad clog to all improvement in lighting and buoying the dangers of the coasts of the United Kingdom, and in support of what I have just stated, I should wish to mention one case out of many in the same class, viz., that of the Londonderry Harbour Commissioners with regard to the Tuns Bank Buoys. About a couple of miles outside the entrance to Lough Foyle, and in the open sea, lies a very dangerous bank, called the Tuns, right in the fair way of vessels making for the Lough. For the safety of ships either trading with Derry or running for shelter in stress of weather to the Lough, it is most essential that this should be well marked, and it was therefore with this conviction that the inhabitants of Londonderry, a good number of years ago, went to the expense of placing two buoys upon it. They have now got an Act of Parliament, accurately defining the limits of their jurisdiction, and authorizing them to levy certain dues for lighting and marking with buoys and beacons all that is within their conservancy. The Act is very clear in stating the purposes for which the dues are to be applied. The Tuns Bank is a good way outside the limits of the jurisdiction of the Commissioners under this Act, and by it they are strictly prohibited from laying out any of the dues collected in the port except on certain works for the maintenance and improvement of the navigation of the Lough within the boundary as detailed in the Act. They have therefore proposed to the Ballast Board to hand over to them these two buoys on condition of their maintaining them. This the Ballast Board considered, under all the circumstances just mentioned, to be but a fair arrangement, and a proposition that they had no right to refuse. They therefore forwarded an application to the Board of Trade for permission to take them under their charge, but that Board, true to their guiding principle, returned for answer "that they had no objection to the "two buoys in question being transferred to the "Ballast Board", provided that the expense of painting and repairing them was met by a small toll on the Trade of the port, but as the Commissioners of Londonderry cannot expend the dues raised under the Act except for the purposes specified by the Act, the demand of the Board of Trade cannot be complied with, and these very important buoys will henceforth be neglected, and when worn out or washed away will not be replaced; most assuredly, when this takes place, which, sooner or later, will take place, a vast amount of calamities must ensue. Hundreds of lives will be sacrificed, and hundreds of thousands of pounds

worth of cargos will be lost, a sad realization of the bitter fruits of that miserable cheeseparing principle that guides the decisions of the Board of Trade.

179. (*Chairman.*) As you were one of the visiting committee of 1859 you can probably inform this Commission whether the floors of the dwelling-houses of the lightkeepers are generally of wood or of stone?—They are generally of stone; but orders have been given to replace the stone floors by wooden floors.

180. (*Captain Ryder.*) When were those orders given?—They have been given at various times.

181. Has any long interval elapsed between such orders being given and their being complied with?—Those orders have not been always complied with immediately.

182. Has more than a year elapsed between the giving of the orders and their execution?—More than a year has elapsed before those orders have been carried out.

183. Have more than four years elapsed?—I hardly think that more than four years have elapsed.

184. (*Chairman.*) Can you state to the Commissioners the system of promotion of light-keepers:—who promotes them, whether it is by seniority, or what the claims are which go to make up a sufficient case for promotion?—Light-keepers are recommended for promotion to the Board by the Inspector, not according to seniority, but according as he thinks the men deserve it.

185. Then it is the Board which promotes, and the Inspector who recommends?—Undoubtedly.

186. (*To Sir James Dombroin.*) Is that system to be maintained?—Returns have been called for of the principal as well as of the assistant light-keepers, and the superintendent has been directed to state in the column of observations his reasons for not recommending men from the position of assistant to that of principal light-keepers according to seniority, to fill up vacancies as they arise on the establishment.

187. Is this return to be made annually?—I shall propose that it shall be.

188. (*To the Earl of Meath.*) You are, I presume, aware of all the circumstances attending the purchase and sale of the Argus?—I am.

189. I believe the building of the Argus was ordered before the Ballast Board came under the control of the Board of Trade?—It was.

190. Was that vessel ordered to be built upon a communication having taken place with the Trinity House?—No.

191. Was she built specially with reference to the service she would have to perform on the coast of Ireland, and that sort of seas that she would have to encounter on that coast?—It was with that view that she was built under the orders of the Board.

192. Then I conclude that the Board furnished her builder with information as to all that she would be required to carry, and the description of service she would have to perform?—He was informed fully of all that she would be required to do.

193. And when the vessel was completed and handed over to the Ballast Board, did that Board intirely approve of the description of vessel furnished to them?—Upon trial she was found to be eminently well fitted for that service.

194. How long was she in the possession of the Ballast Board before she was ordered to be sold?—About two years.

195. In the course of those two years had she been duly and fully employed?—I can hardly say that she had been either duly or fully employed, as there were certain members upon the Board who still hung to the idea of the old system being the better and the more economical with regard to supplying the different stations with stores; but before she was sold, and before she was out of our hands, the Board, I might almost say, had unanimously agreed that the supply of stores would be much better done by her than by the little sailing vessels that were employed. As an example, to show how defective the present system is,—upon the

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inspection of 1859 we found that the sailing vessels with the oil and stores, that had left Dublin Harbour in the first days of the month of May, had not arrived at two of the most important stations on the west coast in the month of September. One of the most important lights on that coast, Slieve Head, the committee of inspection found to be destitute of good oil. There were in the tanks of one of the light-houses 270 gallons of bad oil, which had been condemned four years before; and somewhere about the same quantity in the other lighthouse, which the keepers were burning as well as they could, but giving a very decreased light, so much so as entirely to alter the character of those lights.

196. (*Mr. Gladstone.*) How came it to happen that there was such a quantity of bad oil in one of the lighthouses?—It was a collection of refuse oil for some years which had remained there, as no opportunity had occurred during that period to take it away.

197. (*Captain Ryder.*) Do you find that the oil deteriorates after keeping?—After a year's keeping it is never so good.

198. (*Chairman.*) And after that time it deteriorates rapidly?—Yes.

199. (*Captain Ryder.*) What is the practice with regard to the sale of old stores, bad oil, &c.?—There is a great difficulty in getting rid of them anywhere, particularly at the Rock Stations. The sailing vessels that supply the stations by contract are not paid to take away any refuse, oil, or stores; and as we have not a steamer of our own to go round and collect them, and bring them either to Dublin or to Cork, or Belfast to be sold, they remain a dead loss at those stations.

200. Are these accumulations, of which you have spoken, still existing at the lighthouses round the coast?—They still do exist to some extent; some have been disposed of since.

201. (*Chairman.*) Are the Commissioners to understand that sailing vessels continued to be employed subsequently to the Ballast Board having possession of the "Argus"?—They are employed up to the present moment in supplying stores and oil.

202. They were still employed while the "Argus" was your vessel?—Matters had not been completed to make an alteration before she passed from our hands. Had she been left with us, it was the full intention of the Board to have employed her regularly in supplying stores and oil, and in shifting lightships and buoys.

203. During the two years that she was in your hands was she employed at all in visiting or inspecting by the Board?—She was regularly employed in inspecting by the Board.

204. Was she employed at all for carrying buoys?—Yes, during our inspections.

205. Do you remember the sum that was paid for that vessel?—I think it was about 20,000*l.*

206. Do you know what she was sold for?—I think she was sold for 10,000*l.*

207. Have you heard what has become of her?—I have heard that she was taken out to the Mediterranean and the Black Sea during the Crimean war, and was found to be one of the best vessels that ever went there; she has now, I believe, been purchased by the Sultan, and is used as his yacht.

208. Who was the constructor of that vessel and her engines?—She was built at Greenock by Messrs. Caird.

209. Were the engines by Caird or Napier?—They were constructed by Messrs. Caird.

210. (*Captain Ryder.*) If the Ballast Board was allowed to purchase another vessel for a similar object, namely, to carry stores and buoys for the purpose of shifting light vessels and for the inspections, would the Ballast Board wish to have a vessel like the "Argus" in all respects, or if different in what respect?—I do not think that they could get a vessel more completely fitted to perform all that service than the "Argus," and in that opinion, Captain Roberts,

who commanded her, fully concurs; the one that is at present lent to us periodically by the Trinity Board is totally unfit for the service; we have tried her now for some years, and find that she is totally unable to cope with the heavy weather on the west coast of Ireland. No later than during the inspection of September 1859, we were detained at various places, her captain deeming it dangerous to go to sea, whilst we saw the merchant steam vessels taking the sea and continuing their usual avocations. The Committee were obliged to leave her in the Shannon for nearly a week, and to perform as much of the inspection as they could by cars; in fact, they came round the whole south of Ireland and reached Dublin before the captain thought it safe to take the sea and bring her round there; and thereby the outlying lighthouses were not visited, and valuable time was lost by the Inspecting Committee. I am merely stating the opinions of the entire Board, that the duty of inspection, and of supplying oil and stores, can never be done satisfactorily or safely unless the Board are possessed of a thorough good sea-going steamer to enable them to wait their opportunities to inspect and to leave stores at the outlying lights.

211. (*Chairman.*) How many spare light vessels have you for the Irish service?—I think two.

212. (*Sir James Dombrain.*) We have a second one that might be used upon an emergency, but she is worn out; there is only one regular one.

213. Where are these vessels stationed?—In Dublin.

214. (*Mr. Gladstone to the Earl of Meath.*) Suppose that the Coneybegs light vessel was reported to the Ballast Board by telegraph to be adrift in a gale of wind, what steps would be taken? would you send your spare light vessel in tow by the "Midge"?—Most undoubtedly not; she is quite incapable of doing that service. The only available step to take would be to apply to the Dublin Steam Packet Company to give us a steamer to tow our spare light ship to the place, and it is very doubtful whether, under their pressing engagements, they could give a vessel upon a short notice, and they would have the power of charging any exorbitant sum they might choose to demand, whereas if we had an efficient steamer of our own, the light vessel might be replaced in about ten hours, and further in support of these assertions as to the utter uselessness of the "Midge" for the performance of the duty assigned to her by the Board of Trade, I beg to state the following fact to the Commission:—It was in October last that one of the Burford Bank buoys was reported to have sunk; it was blowing fresh at the time, and the "Midge" was sent to tow the spare buoy to replace the one sunk.—this, after a considerable time spent on the trial, she was unable to do,—she lost her way altogether, and fell back on the buoy, which struck her very heavily under the counter. I am satisfied that any of the small steam tugs of the port of Dublin, and they are all small, would have succeeded, under the same circumstances, in towing out this buoy. Should the "Midge" be caught with heavy buoys on her deck in anything like a gale, and off a lee shore, she will be obliged, to save herself and crew, to throw the buoys overboard, and to do this with the few hands she has, and rolling heavily as she does in bad weather, is a service both of great difficulty and danger. I know that it is Captain Robert's opinion that a vessel of the size and power of the "Vestal" would cost no more in coals while buoy-shifting than the "Midge," as buoys can only be shifted in fine weather. The "Vestal" in a couple of fine days would shift all the buoys between Dublin and Wexford, as she could carry the whole of them, about 20 in number, on her deck; whereas, the "Midge" would have to make about six trips there and back, and if bad weather came on would be prevented from working, perhaps, for weeks. I believe that all that can be said in favour of the "Midge," is, that she sails tolerably well with a fair wind. Her maximum

speed under steam and the most advantageous circumstances does not exceed eight knots; but if there is anything of a head sea and fresh breeze, she hardly goes ahead at all.

215. (*Chairman to the Earl of Meath.*) Are you prepared to say that those members of the Ballast Board who are engaged in lighthouse management would, to the best of your belief, agree with you in the answers with which you have favoured the Commission?—I feel confident that they would.

216. (*Captain Ryder.*) How is the water for the use of the keepers, kept in the lighthouses?—Generally in wooden barrels.

217. Are there any other means of keeping it?—Laterly we have ordered slate tanks to be erected in most of the stations.

218. On visiting some of the Irish lighthouses I found tanks there which had been sent to hold the water, but they had not been erected, and they had been waiting for many months on that account?—That was undoubtedly the neglect of the Superintendent; he had orders to have them erected.

219. Have the lighthouse keepers in Ireland any uniform?—Up to the present time they have not had any, but the Board of Trade have sanctioned the necessary expenditure to give keepers and the light ship crews a uniform similar to that which is given by the Trinity Board to those under their control.

220. Are the lighthouses painted by contract?—No.

221. How are they painted?—By day's work. Men are sent from Dublin to paint them by day's work; but it is the determination of the Board to have them in future painted by contract, the Board supplying the oils and the paint.

222. How is coal supplied to the lighthouses?—By contract.

223. Is it supplied from Dublin?—No; from the nearest town wherever we can make the best contract for a lighthouse.

224. How is the Kish Light vessel's position indicated in a fog?—By a gong.

225. (*Chairman.*) Has there been any proposition from the Ballast Board as to the use of a different description of signal for the Kish Light?—It was proposed by the Ballast Board to have a gun.

226. What was the reason why that proposal was not adopted?—The Board of Trade, I am informed, objected to it, lest it should be mistaken for the South Stack gun.

227. Did the Ballast Board admit the justness of that objection?—Undoubtedly not.

228. Did they state to the Board of Trade their difference of view?—It was so extraordinary an objection that they could not imagine on what ground it could be argued, as it implied a total ignorance by the man navigating the channel of the points of the compass—of his right hand from his left.

229. Can you inform this Commission whence the desire for a gun, as a fog signal, for the Kish Light originated?—The application came from the City of Dublin Steam Packet Company.

230. That is a company, I believe, which runs its vessels between Dublin, Holyhead, and Liverpool?—Yes; I believe they must have nearly a dozen vessels between the Port of Dublin and Liverpool and Holyhead running daily.

231. You are not aware that that company has ever memorialized the Board of Trade as to having a gun for a fog signal at the Kish Light?—I believe they did.

232. (*Mr. Gladstone.*) Did the Trinity House take any part in the question?—No.

233. (*Chairman to Sir James Drombrain.*) You have heard what Lord Meath has stated as to the accumulations of condemned oil at the various lighthouses, and the reasons stated by his lordship for those accumulations. Have any steps been taken to alter that state of things?—Yes. On our last inspection we found that these accumulations were still

going on, and we reported specially to the Board one or two cases, and one particularly, namely, the Old Head of Kinsale, where stores had accumulated for several years, and where a man was paid 7s. or 8s. a week to take care of those old stores for about eight years. In other cases we found, as we went on, that the old stores were not disposed of, and we took upon ourselves, as the Inspecting Committee, in order that this might be done away with at once, to direct the light keepers to get proposals for the purchase of the old stores, it, in their opinion, the estimates were fair—to accept the sums offered—we thought it not worth while to let that state of things remain any longer. We thought it a great pity that they should be deteriorating every day, and we desired them therefore to accept the highest tenders that came, and to remit the amount immediately to the Ballast Board. Of course Mr. Halpin was called upon for an explanation as to these accumulations, and Mr. Halpin stated that he had called on several occasions for tenders, but, in consequence of their not coming up to the amount which he thought the things ought to have realized, he did not accept them, the power to accept or reject them having also been with Mr. Halpin, and these were matters which, in fact, were never brought before the Board at all.

234. (*Captain Ryder.*) Are there still old stores unsold at the exposed Rock stations?—I believe there are still some unsold, but I will not be positive upon that point, because I think it is very likely that Mr. Halpin may, since our inspection, have caused a good many of them to be sold.

235. Are you aware at the Ballast Board of any outstanding accounts in the matter of lighthouses?—On our last inspection we found, at three stations in particular, that there were outstanding accounts and the first one was at Rathlin Oberine, and it was about four years old; they were disputed accounts by the superintendent, but we had not been informed of their existence before.

236. (*Chairman.*) Has the superintendent a balance in hand out of which to meet outstanding accounts at whatever time they may be presented?—The Superintendent, in his annual estimates, provides for every contingency at each station, and if any lapse in one year they are provided for in the next estimates, consequently, whenever those accounts are presented, he has the means of immediately certifying them when they are paid; they go to the Board first.

237. (*Captain Ryder to the Earl of Meath.*) Are there any lighthouses which the Ballast Board are of opinion should be built without delay?—There is one very important point at which they would desire to have a light, either on the Blaskets or on the Foze, so as to lead ships from the southward into the Shannon. We have placed the project before the Trinity Board, and they have agreed that a light should be placed there, and they have recommended, in preference, the Foze.

238. What are the distinctive features of those two sites?—The Foze is an outlying rock of rotten construction, and about 800 yards in circumference.

239. Is that the site that you proposed?—We recommend the Foze Rock, should it be found practicable to erect a lighthouse on it, but failing in that, we suggest that one should be built on the outer Blasket; this island lies about one mile and a half inside the dangers, and rises nearly to a height of 200 feet above the sea. There is no doubt that the Foze is the preferable site of the two, and as the Trinity Board concurred in that view, our superintendent sent a foreman to watch his opportunity to get on the rock; he remained there for several months, and once effected a landing for about a quarter of an hour, and he took a ground plan of the rock, and brought off specimens of it. Our superintendent is of opinion that before any light could be erected on that rock, it would be necessary

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to cut it down to nearly the surface of the sea; he does not consider it altogether impossible to build a tower on this rock, but it will be undoubtedly a work of time requiring the very highest engineering skill, and a very great expenditure of money, and, I fear, will be attended with great loss of life whilst building, and when finished, if ever it is, a most insecure and dangerous position for a light, and for the persons who will have to attend it; whereas on the outer Blasket there will be but little difficulty or expense in erecting and maintaining the buildings required.

240. (*Captain Ryder to Sir James Dombrain*). Has the Ballast Board received any application from Galway for the improvement of the light exhibited on Mutton Island in that bay?—Yes; an application was made by the Harbour Commissioners of Galway to the Ballast Board to place a light ship to mark the Marguerite rock in the entrance of Galway Harbour. One of the Lever line of packets ran upon it, and many wrecks have taken place within the last 30 years. Another proposition was to alter and improve the character of the Mutton Island light, the Ballast Board fully concurred in the necessity, and the Trinity Board agreed with them, but on an application to the Board of Trade they stated that as this appeared to be for local purposes they would not sanction it. Upon that subject I should say that I think a much broader and more comprehensive view ought to be taken by them generally with regard to the coast of Ireland. There is very little trade on the west coast of Ireland and all its harbours from which you can draw any funds to keep up these lights, buoys, or beacons, whilst the whole of the west coast of Ireland is it seems calculated for asylum harbours, and it is run for by vessels that get into distress, and various things of that kind occur, and you cannot look to local means to support lights, buoys, or beacons. There are many cases—for example, in Crookhaven, sometime ago, we recommended that a beacon should be placed on the Alderman Rock at the entrance to Crookhaven, but the Board of Trade refused it on the ground that it was entirely for local purposes. I then, on my individual responsibility, stated to the Board that I had seen as many as 60 or 70 vessels, of many nations, at anchor in Crookhaven; it is a great port for vessels caught by easterly winds, homeward bound, to make for to wait a change of wind. I stated this, and the Board thereupon put it very strongly to the Board of Trade, who yielded at last, and sanctioned a beacon being placed there. Since that, applications have been made to the Board of Trade, and memorials have been addressed to them from a number of influential persons in the country, and from the masters of numerous vessels which were lately detained in Crookhaven from stress of weather, urging upon their lordships to allow the light to be removed from Crookhaven to the Alderman Rock, upon the ground that the cost of the beacon and the cost of the tower to put the light upon would be so immaterial, and the light being so very important, in consequence of the extreme difficulty in distinguishing the Alderman Rock at night, it being so low, whilst all the land very near to it in the back ground is so high, and they thought it might have been done at the same time, as the one would be almost as expensive as the other. Upon turning back to the original papers under which the light was erected at Crookhaven, I found that the former superintendent, Mr. Halpin, under whose direction it was built, stated that there could be no question but that the Alderman Rock was the better place for it, but he had his doubts as to the solidity of that rock to bear a light-house. Of course I assume now that Mr. Halpin, the present engineer, must have satisfied himself of the solidity of the rock, inasmuch as the beacon to be placed upon it in all probability would be much heavier than the tower for the light, because it is to be a solid structure, and to cost 1,100*l.* or 1,200*l.*, and one of the grounds upon which the Board of Trade had refused the application for the tower was

that the Alderman Rock was a tidal rock, but such is not the case—the rock is at least 18 or 20 feet above high water spring tides.

241. (*Chairman*.) You have mentioned an instance in which the Board of Trade had declined to establish a light for general purposes, considering it to be a local light: are you aware of any difficulties occurring in the matter of buoyage from a similar view being taken by the Board of Trade?—Perhaps, before I answer the latter part of your question, I may refer to another case, of vast importance in my opinion, which is the Copeland Light. Very strong representations were made to the Ballast Board and to the Board of Trade upon the subject of that light and fog bell, and a committee of the Board was appointed, of which Lord Meath was chairman, they went down and went most thoroughly into the subject with the Belfast Harbour Commissioners, examining the whole matter in the closest detail, and they came to the determination that it was highly important and necessary that the light should be lowered from the Copeland and put upon the Mew Island, with a fog bell to it. The Mew Island is an outlying danger, at least a mile from the Copeland Island. More recently, upon fresh representations being made to the Board of Trade, the Elder Brethren were ordered to meet the Committee of the Ballast Board, and to go down to see how far they concurred in the view of the committee which was appointed by our Board. We met them there, and they went into the subject, and also strongly recommended that our suggestion should be carried out. The Board of Trade, however, say that this is more a harbour light, and more for Belfast than for the general trade, and that unless the Belfast people are prepared, by a tonnage upon shipping, to contribute to the expense, they will not sanction it. Now it is no more a harbour light than any other light that I know upon the whole coast of Ireland. It is a leading light for the Channel, the great leading light for all vessels either coming into the Channel or leaving it; and a bell would be most important, for that coast is very subject to fogs, arising it is supposed from the very extensive back-water of Strangford Lough. There is no question in the world that many a vessel would have been saved had there been a light and a bell upon Mew Island; but it remains now in that state that the Board of Trade have said they would not grant it unless there was a contribution from Belfast. The proposition of the Board of Trade was that the Harbour Committee of Belfast should contribute one third of the expense, by means of levying an extra tonnage rate upon all vessels going into their port, until that third was raised; and in that case the Board of Trade would consent to defray the other two thirds. The Ballast Board have again represented in as strong terms as they could their opinion that this ought not by any means to be considered as a local light, or that local funds ought to be contributed towards it; but notwithstanding this strong expression of their views, it has again been refused: we can only regret that the views and opinions of two such bodies as our own, and the Trinity Board should have so little weight. It should be remembered that the Ballast Board in Ireland are looked upon by the Irish public as the controlling body in matters of this kind; and it certainly does occasion a considerable amount of dissatisfaction when their representations upon subjects like this of great and important interest to the commerce of this country are disregarded.

242. Have there not been wrecks lately in the neighbourhood of the Copeland Light?—Immediately on the Mew Island there have been, I believe, three steamers lost upon it.

243. (*Captain Ryder*.) Recurring to your answer with regard to the Mutton Island Light, it appears that by the decision of the Board of Trade, however much the trade of Galway may increase and however important it may be for the Mutton Island Light to be improved, the Mutton Island Light, being a general light but in fact being treated by the Board

of Trade as a local light, cannot be improved, but must remain for ever an inferior light?—The arrangement entered into originally with the Board of Trade, when the Irish Lighthouse establishment was placed under their authority by the Merchant Shipping Act, was this—that the Board of Trade agreed to maintain all our existing harbour lights intact, but would not sanction any fresh harbour lights, involving increased expense, unless they were supported by local contributions or by local means.

244. Has the decision of the Board of Trade with regard to the Mutton Island Light been submitted to the Harbour Commissioners of Galway?—Yes, it has.

245. What was their reply?—I do not think that any reply was received from them, although a communication took place about two years since.

246. Was there not, at the time when the Board of Trade received under the Merchant Shipping Act the control over the Ballast Board, a large balance in the hands of the Ballast Board?—Yes, 100,000*l.*, which was handed over to them.

247. For what purpose had that 100,000*l.* been accumulated?—For the purpose of placing additional lights and additional buoys and beacons round the coast; it was to meet any expenditure of that kind which may have been found necessary. And considering that the Board had about that period taken a very deep interest, by its inspections round the coast, they would have found abundant ways of employing that money most usefully for the benefit of the trade of the country.

248. What sum of money has been laid out by the Board of Trade, and what liabilities have been incurred by them up to the present date, for Irish lighthouses?—About 40,000*l.*, including the Calf Rock, the estimates for which have not yet been allowed, although recommended by the Ballast Board, amounting to 17,000*l.*

249. Had the 100,000*l.* of which you have spoken remained in the hands of the Ballast Board what works would you have undertaken which have not been undertaken at present?—It would be exceedingly difficult to answer that question satisfactorily. Of course if we had had the means we would have gone perhaps rather in advance of the applications to us, and have expended at least the interest arising from that sum, which was from 3 to 4,000*l.* a year; on going round the coast, as we have done as a committee of inspection, we have seen many things that it would be very desirable to do on general public grounds, but which we know, unless applications were got up to the Board of Trade, and they proved to be questions of general utility, they would not be listened to. We would have taken many things in hand, I have no doubt, a vast number of things, as to the marking of the coast in various ways by buoys and beacons, which would have been of very great general utility; but, knowing how we stand with the Board of Trade, we could not submit any one of these things to them under existing circumstances, particularly with respect to illuminating and marking harbours of refuge.

250. What are the principal harbours of refuge on the coast of Ireland?—I will begin from Dublin and take Waterford.

251. Is that, as a harbour of refuge, well lighted and marked?—No; it is not.

252. What does it require to complete it as a harbour of refuge?—It requires either a light or a beacon on the spit near Passage; it was lately applied for, and the Trinity Board did not concur with the Ballast Board in the necessity of it, inasmuch as they considered it was local, and not necessary for the general shipping, but I entirely differ in that view. The next are Crookhaven and Long Island. Very recently the Board of Trade have referred to us an application to place a beacon at Long Island, at the east end.

253. Is there any local trade there that is benefited by that beacon?—Very trifling indeed.

254. Had there been a local trade there that would have been benefited by that beacon do you think, judging from your experience as to other applications, that the Board of Trade would have consented to placing beacons there?—No; I think they would have refused it.* The next harbour is Berehaven—that is a very important one.

255. What are the marks there?—There is a light at the eastern entrance on Rhuancarrig, and a beacon tower at the western entrance, so constructed that it can be at any time converted into a lighthouse tower; and I think it would be very important, when the Calf is lighted, that that light should be exhibited to show the other entrance—the second entrance into Berehaven.

256. It is a considerable harbour of refuge, is it not?—Yes.

257. Has any application been made with respect to that?—No. There were applications originally about placing a beacon tower there, and we did that; we built that at a cost, I suppose, of about 1,000*l.*, and there it stands at present. The next is a part of the coast where I have known vessels take refuge on three or four occasions, and very large vessels; but it is a port very little known; it is the Kenmare River. There are two harbours in it, the harbour of Sneem and Kilmichaelogue, two remarkably good anchorages, and which, I think, it would be very desirable, inexpensively, to mark by beacons—small beacons, which would cost very little indeed, and still they might be highly serviceable.

258. Has any application been made upon that subject?—No; I do not think there has been; but these are things, as I said before, which, if we had had the means at our own disposal, the Committee, going round and seeing the utility of them, would have had no hesitation whatever in doing. The next is Valentia, which was well marked previous to the passing of the Merchant Shipping Act; that is pretty well defined, and more especially it will be if a light be placed, as recommended, upon either the Foze or the Blaskets. It would be great leading light for the Shannon as well as a general coast light. After leaving Galway there are several safety harbours, in which vessels occasionally take refuge. For example, there is Caslah Bay; that I do consider a very important one. There is one beacon upon a rock at the entrance of it. It has plenty of water—seven fathoms—and it is one which we would have marked more distinctly than it is at present, had it been under our control. After that, is Black Sod Bay, where we very lately recommended beacons to be put, but it was refused upon the usual ground that it was local, and must be kept up by local means. Then, after that, you come to a harbour of refuge, called Broadhaven, which was well marked previously to the passing of the Merchant Shipping Act. The Bay of Killybegs, in like manner, is well marked. Lough Swilly is greatly improved by the buoys which have recently been placed there under the authority of the Board of Trade, on the recommendation of the Inspecting Committee, because it was a harbour of refuge. With regard to Lough Foyle, a proposition was laid before us the other day by the Londonderry Harbour Commissioners to be allowed to improve their harbour by putting up another light inside and within their jurisdiction, which we have consented to. But the Tuns buoy remains under no person's charge. The Local Board deny that it is under their jurisdiction, and, consequently, if it is washed away it will not be replaced. Then we come to Larne, which was well marked previously to the passing of the Mercantile Shipping Act,

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* Next to Crookhaven is Dunmanns Bay, in which there is very safe and secure anchorage above Carberry Island. I have known two or three very bad wrecks, with great loss of property occur from the want of a beacon to guide vessels to the above anchorage.

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and then to Belfast, as to which there is a great question now about the Copeland. Belfast is most decidedly a harbour of refuge, and the light is one unquestionably for general purposes. I do not think that we can call any others harbours of refuge, inasmuch as they are tidal down to Dublin. Strangford and Carlingford are both tidal harbours, and therefore cannot fairly be considered harbours of refuge.

259. Are the Commissioners to understand that the Board of Trade, as a general rule, have no objection to marking and buoying bays, which may be considered, or which may serve as Harbours of Refuge, provided there is no port inside them, but that they refuse always to light those harbours?—Having experienced so much difficulty in getting harbours of refuge marked and buoyed, we have not applied for lights, knowing that they would be refused.

260. Has the Ballast Board any intention to propose the erection of any beacon on the Coneybegs Rock?—No, I believe not. We think that a light vessel there is the best way of marking it.

261. What were the circumstances attending the application from the Ballast Board for permission to place a buoy on the North Briggs?—

262. (*To the Earl of Meath.*) When I visited Limerick I was informed that within the last 20 years all the buoys, amounting to more than 20 in number, which marked the estuary of the Shannon, had been gradually washed away, and never replaced, leaving the numerous dangers and shoals in that estuary entirely unmarked. Will you refer to Section 394 of the Merchant Shipping Act, and say whether the Ballast Board has not power under that clause to insist upon the Local Board at Limerick replacing such of those buoys as are within the line of jurisdiction marked out by their Act of Parliament?—I was not aware of the power given to the Light-house Boards in the United Kingdom by that section of the Act, and I have strong doubts whether that authority has ever been exercised by the Ballast Board.

263. Are you of opinion upon perusing that clause that the Ballast Board has the power which I have spoken of?—It appears to me very clearly that they have the power.

264. (*Chairman.*) You stated, I think, that you were not aware of the existence of such a power as is given in those sections. Is there any law adviser now attached to the Ballast Board, or is there any professional person to whom you habitually refer in any case in which you have doubts as to your power of action?—We have a solicitor, and we take the opinion of the Attorney-General for the time being on any difficult point of law which may present itself.

265. (*Captain Ryder.*) Can you recall the circumstances attending the loss of the yacht belonging to the Marquis of Drogheda off the Harbour of Sligo?—I recollect the occurrence. He had got the last Admiralty Chart on board, on which was marked a buoy to show a bank at the entrance of the river, and he, on a fine morning, went in to look for this buoy, and in looking for the buoy he got on the bank where his yacht was lost, the buoy having been washed away two or three years before and never having been replaced. This buoy was under the jurisdiction of the Harbour Commissioners of Sligo.

266. Ought those Harbour Commissioners to have reported to the Ballast Board at Dublin the circumstances of their having abandoned any intention to replace that buoy?—I believe there is nothing requiring them to do that.

267. (*Chairman to Sir James Dombrain.*) Have any communications passed between the Admiralty and the Ballast Board on the subject of the Roche's Point Light, or upon any other subjects connected with lights?—I recollect, upon the subject of the Roche's Point Light, that a communication was made from the Admiral at Queenstown; but, prior to that, a strong recommendation had been made to the

Ballast Board, upon the necessity of a light between Roche's Point and the Hook Tower, and the Board upon that representation—immediately took measures for placing a light on Cable Island; they entered into contracts for it, and a part of the tower is at this moment standing; this was previous to the passing of the Mercantile Marine Act.

268. Were the communications upon this subject between the Ballast Board and the Admiralty?—Yes; and they represented it very strongly, and, as I have stated already, it had so far progressed that part of the tower is at this moment standing on Cable Island. They took the land, and they commenced building the tower, when some representations were made to the Admiralty by the merchants of Cork, and the Admiralty immediately communicated with the Ballast Board, and recommended, instead of the one light on Cable Island, that there should be two lights—one on Ballycotton Island, and the other on Minehead; and upon that representation those two lighthouses were built.

269. The light dues on coasting vessels, including vessels navigating between English and Irish ports, and navigating the English Channel as well as the Irish Channel, have been very greatly reduced, have they not?—They have been greatly reduced, and they always were much lower in Ireland than it either England or Scotland.

270. But that would not affect them in the English voyage, where they had to pay English dues upon English lights?—No.

271. Is it still the case that vessels, having any weight on board at all, not strictly ballast, are obliged to pay light dues?—It is a subject that has very frequently been brought under our notice, and only the other day we were obliged to inflict a fine upon a merchant in Dublin for taking what he called dunnage, but which was evidently in lieu of taking the ballast of the Corporation, because every vessel taking in ballast is bound to take it from the Ballast Board, and this person, in shipping fifty or sixty jars of vitriol managed to take fifty or sixty tons of dross from his vitriol works which he called merely dunnage; but when he got over to Whitehaven, the place to which the vessel was going, he paid a man sixpence a ton to discharge this from his vessel into the sea, and that came to our knowledge, and we found it necessary to summon him and the captain of the vessel, and we inflicted a penalty of 10*l.* upon him, as it was an evasion of the law as to taking ballast.

272. Are the Commissioners to understand that a vessel carrying anything but ballast would be chargeable with light dues?—Yes; having any cargo.

273. Has not that law been found to operate prejudicially upon vessels which would come back with small and perhaps remunerative cargoes but for having to pay the light dues?—No; I do not think it would operate in that way. We have frequent instances coming before us of vessels claiming exemption from light dues from various causes; for example, a vessel may come in for a market with potatoes, and she cannot make her market, and there she is subject to light dues; but we remit them in cases of that kind, and every leniency that the Board can show is shown towards trade in those respects. It is not their wish to enforce heavy dues for merely trifling things, and it constantly occurs that we remit those dues.

274. Would it not act slightly in this way, that whereas Ireland is essentially an exporting country, from the nature of its produce it would become to a greater extent an importing country if vessels were allowed to bring in a small portion of cargo without having to pay light dues on their whole tonnage?—I think it would be exceedingly difficult to draw the line to know what would be a fair proportion on a vessel, the tonnage of which would be, say sixty tons, and so on; as the tonnage rises you would have to have a sliding scale, showing how much you would

allow each vessel to carry without paying light dues.

275. If you could establish a minimum freight upon which no light dues were to be charged, do you think that that would be a benefit to the owners of the coasting vessels?—Unquestionably to that extent it would be, but the light dues are so exceedingly light that I do not think it would operate at all upon the trade.

276. (*Captain Ryder.*) How many keepers are there at Roche's Point?—Only one.

277. What are his instructions for night work, as to remaining awake?—He is expected to remain awake the whole night.

278. Even during the whole winter's night of 15 hours?—Yes.

279. Do you think it possible that one man can do his duty properly through so long a period at night?—Certainly not; and upon our last inspection we urged upon the Superintendent to pay again the money the lightkeeper had paid for a person to assist him during the previous winter, and we also urged upon the Superintendent, upon next preparing his estimates, to provide for an occasional assistant, at all events for the winter.

280. Are there any other such lights on the coast of Ireland, with only one keeper?—There are several lights with only one keeper, but not one of the importance that that is.

281. Then there are some lights so unimportant that the men in charge of them may go to bed?—I cannot say that; I should be very sorry to say that as to any light, but I mean that they are not of that very important character that Roche's Point is, in such cases the Lightkeeper's family assist him.

282. How then is the duty performed when there is no family?—We are careful to place men who have families where there is only one keeper employed.

283. Are you of opinion that it is right that there should be only one lighthouse keeper at any lighthouse under your Board?—Certainly I am of opinion that there ought to be two, and I believe that that is the opinion of every one of the members of the Inspecting Committee; but, under the regulation under which the harbour lights were to be maintained in their integrity as they stood by the Board of Trade, we feel that we could not well ask them to grant another keeper, because they would immediately say, that is an increased expense that was never contemplated, it entered into no part of our bargain.

284. (*Mr. Gladstone.*) How many keepers are there at the rock stations?—We have just succeeded in getting permission from the Board of Trade to have a third man always present at a rock station, where the families are not able to be accommodated; the only exception is the Black Rock in the entrance to Sligo, the reason being that it was too near the mainland.

285. How long were you in obtaining that permission?—I think we had been applying for it for three years.

286. (*Chairman to the Earl of Meath.*) Your correspondence has been, I presume, considerably enlarged, from the jurisdiction under which you are now placed, namely, that of the Board of Trade?—It has been very much augmented.

287. (*Captain Ryder.*) Does it require any addition to your staff?—Occasionally we are obliged to get in additional help, but the whole subject has been referred to the committee, to see in what manner the generally increased work can be fairly apportioned amongst the subordinate clerks, and what additional assistance may be required.

288. (*To Sir James Dombrain.*) Is there any system of signals used?—They have now been sanctioned by the Board of Trade, and orders have been given to carry them out.

289. Has there been any application to the Ballast Board to show tidal signals at the Hook Lighthouse?—Not any.

290. (*Mr. Gladstone to the Earl of Meath.*) You have been speaking of many large questions, such

as the erection of lighthouses; do those questions come before the whole of the Port of Dublin Corporation or before the Committees?—Before the whole Board. The Visiting Committees make a report on all subjects that may come under their observation to the Board as soon as they return, and they daily in their tour round the lights constitute themselves into a Board, and put down their observations seriatim on all points; having done that, they make a resumé of that in the shape of a report, but both their daily observations and the report are given on their return to the whole Board.

291. What proportion of the time of the General Board of the Port of Dublin Corporation is given to the subject of lighthouses, buoys and beacons?—We meet twice a week in Dublin; one day in the week is devoted exclusively to lighthouse business, and the other day to the Port of Dublin business.

(*Sir James Dombrain.*) I would add to what Lord Meath has stated, that we have other committees; for instance the Inspecting Committee and various others, and anything that may occur, almost everything upon the coast that has been reported upon by them, and anything that arises upon it, is all referred back to the Committees, and if there is any question, then the Committee meet and report again to the Board; and in this way the time of some of the members is almost wholly occupied.

292. (*Captain Ryder.*) In a case of emergency who is it that acts?—The Board are specially summoned in any case of emergency.

(*The Earl of Meath.*) A Board can be formed any day of the week as there are so many members who live in town within call.

(*Sir James Dombrain.*) Frequent special Boards are summoned.

(*The Earl of Meath.*) And besides that, members of the Board call in constantly during the week to see what is going on, and to hear what communications may have been forwarded to the office since the last day of meeting.

293. (*Mr. Gladstone.*) If any scientific improvements are suggested to the Corporation, to whom are such questions referred—suppose for example that the Electric Light were suggested?—To the whole Board, and it would be discussed before the whole Board.

294. Have you any scientific gentleman specially attached to the Board?—As such, we have none.

295. Do you know whether any experiments of a scientific character are made?—Only by the Superintendent.

296. (*Chairman.*) Would that be under the directions of the Board?—Yes.

297. (*Mr. Gladstone.*) Are you aware of any particular experiments which the Superintendent has either been directed to make, or has himself originated?

(*Sir James Dombrain.*) I think there have been some; for instance, the intermitting light, and things of that kind; they originated with the Superintendent, and a great deal of machinery has been invented by him and improved upon. Before concluding, may I be permitted to add, that I am anxious to bear my testimony to the general good character of the lightkeepers; complaints are very rare, their families are as well brought up as their means will admit, and they appear extremely grateful to the Board for their consideration, in supplying them with small libraries for their instruction and edification. The Board have also been induced to recommend to the Board of Trade to allow the men for medical attendance, and to sanction a plan of life insurance on the same principle as is at present allowed lightkeepers under the Trinity Board. Directions have also been given for improvement in the present dwellings of the lightkeepers, although I am sorry to say in this respect their intentions will in future be counteracted by the Board of Trade. In the houses which are to be built for the lightkeepers for the Calf Rock, the accommodation that our Board proposed to give the

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keepers has been circumscribed by the Board of Trade. I think this extremely injudicious; the men are placed in most remote situations, thrown entirely on their own resources for society, and generally with large families. Every comfort therefore, consistent with their position should be readily accorded to them, and, above all, ample room for their large families, in some instances consisting of 10 or 12 children.

298. (*Chairman to the Earl of Meath.*) Have you ever had any difficulty in making a Board?—None whatever. We are an unpaid Board; and yet, to my certain knowledge, but two instances have occurred

during the last eight years, when a sufficient number of members did not attend to form a Board on the regular day of meeting; and in both instances special meetings were held on the following days.

299. You have heard the evidence given by Sir James Dombrain, do you concur generally in the tenour of that evidence?—I do thoroughly.

300. (*To Sir James Dombrain.*) You have heard the evidence given by Lord Meath, do you concur in all that has fallen from him?—Quite so.

Adjourned till Thursday next at 12 o'clock.

Tuesday, 18th December 1860.

PRESENT :

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON, R.N.

Captain ALFRED PHILLIPS RYDER, R.N.

JOHN HALL GLADSTONE, Esq.

SAMUEL ROBERT GRAVES, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

*T. H. Farrer,
Esq.*

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THOMAS HENRY FARRER, Esq., (Secretary of the Marine Department of the Board of Trade,) further examined.

301. (*Chairman.*) Is the President of the Board of Trade unable to attend to-day?—He has just written to me to say that he is ill, and will be much obliged if the Commissioners will postpone his examination.

302. Since you favoured us with your evidence on the 7th instant, the Board of Trade have been so good as to furnish this Commission with a précis of the case of the Great Basses Lighthouse. That is a case with which, I presume, you, as Marine Secretary of the Board of Trade, must be more or less acquainted?—Yes.

303. It would appear from the paper sent to the Commissioners, that since 1855 more than 40,000*l.* have been expended for the purpose of erecting a lighthouse on the Great Basses, and yet that there is no apparent intention to erect any lighthouse there; that in fact directions have been given by the Board of Trade for the sale of the materials already sent out to Ceylon, and that the Board of Trade are waiting for a report from the Governor of Ceylon before taking the final steps to establish floating lights off the Great Basses?—Yes.

304. Are you in a position to state what the actual sum is that has been expended for the purposes of erecting a lighthouse on the Great Basses?—I cannot state it with certainty, because some of the accounts of the resident engineer are not yet finally settled, and because we do not know whether the materials and lighting apparatus which have been sent out are sold or not, or what they will fetch; but I believe we may put the total expense at somewhere between 40,000*l.* and 50,000*l.*

305. I observe in the return sent from the Board of Trade on the 5th of July 1859, that the original estimate for the cost of the Great Basses is put at 33,916*l.*; would it not be better if it were entered in this return as an amended estimate?—Yes, I think it would. It was put there as the original estimate upon which the Board of Trade undertook the work. A previous estimate was given by Mr. Gordon for a smaller sum, but the plan upon which that estimate was based was considered not satisfactory. After a great deal of discussion between Admiral Beechey and the various persons whom he consulted on the subject, the original plan was enlarged, and the consequence was an increased estimate.

306. (*Captain Ryder.*) What was the amount of the original estimate?—The original estimate given to the Board of Trade with the plans was 18,689*l.*

307. (*Mr. Graves.*) You allude to Mr. Gordon's estimate?—I allude to the first estimate Mr. Gordon gave us with his original plans.

308. (*Chairman.*) In Mr. Milner Gibson's answer on a former occasion mention was made of the means at the disposal of the Board of Trade for coming to

a right decision upon particular cases relating to lighthouse control and management, and the course taken on such occasions was to some extent specified by the President of the Board of Trade. Do you recollect Mr. Milner Gibson's statement on that point?—Yes, I have a general recollection of it.

309. Are you aware whether in the case of Mr. Gordon's original estimate of 18,689*l.* for a lighthouse on the Great Basses that that estimate was referred to any of the lighthouse authorities for their opinion?—I think perhaps I had better say, in the first instance, that, as I understood Mr. Milner Gibson on the last occasion, he was referring rather to the duties which the Board of Trade has to perform in connexion with the other lighthouse boards than to the executive work which they may have had to do with regard to colonial lighthouses. With regard to colonial lighthouses, which they themselves erect, of course they are obliged to employ professional persons, and, so far as the professional work is concerned, of course they must be guided by the advice of those professional persons whom they employ. In that respect the executive duties the Board of Trade performs with regard to colonial lighthouses differ from the duties which they perform in controlling the expenditure of the three lighthouse boards. With regard to the particular question relating to the Great Basses, I should mention, in the first place, that the person who could have given the fullest information upon this subject is unfortunately gone, Admiral Beechey. I have personally but a limited knowledge of all that passed on that occasion, for there was a great deal of work in the Board of Trade connected with the Merchant Shipping Act at that time which occupied me, and I am not able to give a full or detailed account of all that passed between Admiral Beechey and the different persons whom he and Lord Stanley of Alderley consulted with respect to the Great Basses. But I happen to know that Admiral Beechey did consult a great many persons upon the subject of the Great Basses Lighthouse. I know, for instance, that he was in constant communication with the late Deputy Master of the Trinity House about it. There was no official communication with the Trinity House, for the obvious reason that if we had referred to the Trinity House officially they would have told us that they could, if we pleased, obtain for us a report from Mr. Walker on the subject, and we should then only have been having one engineer criticising the work of another, a thing which I believe no professional person likes, and certainly a thing which engineers do not like, and which would never end well. But Admiral Beechey did consult the Deputy Master of the Trinity House, and many other experienced

persons. He was very anxious about these plans of Mr. Gordon, and was for weeks constantly discussing them with Mr. Gordon, and consulting the Deputy Master and other competent persons about them. His private papers, which would no doubt show much that he did, are not with us; but I see from notes on the official papers that on particular points he had conversations with and consulted Sir Roderick Murchison and Mr. Walker. I see that, for instance, he took their advice about the stones to be used. I know, in short, though I cannot give the particulars, that Admiral Beechey bestowed a great deal of labour and thought upon these plans, and got all the information that he could. What that information was, and what that advice was, there is nobody now living, I believe who can say; but I think it is obvious, from the very fact that Mr. Gordon's original plan, which was to cost 18,689*l.*, was, by the intervention of the Board of Trade, raised to 33,000*l.* or 34,000*l.*, that some pains were taken in criticising Mr. Gordon's original plan.

310. Do you recollect the amount that was included in the amended estimate for the steamer, which Mr. Gordon had not considered necessary?—I believe that the 15,000*l.* by which the estimate was increased, is due to the addition of the cost of the steamer, and to the substitution of a stone basement to the tower for an iron one.

311. (*Mr. Graves.*) By whose recommendation was it that the iron basement, which appeared to be in the original plan of Mr. Gordon, was changed for a stone basement?—It was certainly done by Lord Stanley of Alderley's direction, and no doubt on Admiral Beechey's recommendation. But who further advised Admiral Beechey on this point I cannot say with certainty. I know that there was a great deal of consultation about it, especially with the late Deputy Master of the Trinity House; but I cannot, as I said before, tell you all the steps that were gone through, or all the persons who were consulted about it. I happen to know that there was great discussion upon the character of the stone to be used; that Darley Dale stone was proposed; that Sir Roderick Murchison and Mr. Walker were consulted as to whether that stone was a proper stone; and that it was decided that granite, although more expensive, was preferable.

312. (*Chairman.*) Would it be convenient for you to produce the letter of the 15th of September 1855, Mr. Gordon's first report, which would naturally include plans and estimates?—Certainly. I will put in a copy of all these papers. (*Here the witness put in a paper marked A.*) I will also send to the Commissioners the original drawings and plans; but these last we should be glad to have back again.

313. I conclude that the Board of Trade, exercising a controlling power in lighthouse matters, were aware of the cost of the erection of certain lighthouses in these islands having some analogy to that to be erected on the Great Basses, such as the Skerry Vore Lighthouse on the west coast of Scotland, which cost in round numbers 90,000*l.*, the Bell Rock, on the east coast of Scotland, which cost in round numbers 61,020*l.*, and others. It would be natural, I presume, to compare the estimate sent in for a lighthouse on the Great Basses with the cost of such lighthouses as I have mentioned. Do you know whether any such reference was made to the cost of previously erected lighthouses?—I have not the slightest doubt that it was, although I have no recollection at all upon that subject. As I have said before, I do not know all that passed, but I have not the slightest doubt that such reference was made. It was one of the things on which Mr. Gordon prided himself, that by means of his iron work he was enabled to do works of this description much more cheaply than they had been done by other boards. I should mention that any very slight difference in the circumstances, such as the height of the rocks out of the water, &c., will make all the difference in the comparative cost of a work of this description.

314. It would appear that subsequently to July 1858 the Governor of Ceylon represented to the

Board of Trade that he considered Mr. Gordon's estimate of the probable cost of what remained to be done for erecting the light as far too low, and that Mr. Gordon had understated the time in which the work could be completed, and that in a subsequent despatch the Governor states that Mr. Poindestre had informed him that he estimated the yearly expenditure, including a steamer at 20,000*l.*, and the duration, of the work at five years; that he the Governor had gone carefully into the grounds of this computation and was satisfied that they were substantially correct. The Governor also expresses a belief that had the difficulties of the work been properly understood it would never have been commenced; but that nobody knew them, and that many of the facts which had been gathered were the results of recent experience. Have I stated the case accurately?—That is what the Governor stated.

315. It would appear, then, upon this, that the Board of Trade wrote to the Governor, informing him that steps involving further expenses must be delayed until the Government had determined what course to take. Do the papers now sent to the Commissioners show precisely what the course is that the Government do intend to take, or have any fresh steps been taken since November last, which is the date of the papers sent to the Commissioners?—All the papers that we have had recently, that is to say, the accounts of the Admiralty survey, confirm Captain Sullivan's opinion, that the proper mode of lighting these dangers will be by lightvessels; but no final steps have been taken, or can be taken, until the Board of Trade receives the Governor's report giving a detailed estimate of the cost of building lightvessels in Ceylon or at Bombay, and a report on the mode of communicating with the lightvessels when established, and on the cost of maintaining them.

316. (*Captain Ryder.*) How is Mr. Gordon, the engineer, paid, who was employed to make the estimates; by a fee, or by a commission on the estimates?—By a commission on the outlay.

317. (*Chairman.*) I see by the return sent to the Commissioners from the Board of Trade on the 5th July 1859, that the list of the lighthouses in the colonies, under the control of the Board of Trade, then in course of erection, ends with the Great Basses. Are there at this moment any other lighthouses, either in course of erection or for which estimates have been prepared, that are not included in that list, or is it in contemplation to erect any other lighthouses in our colonies?—There are some lighthouses in some foreign countries which are needed for the wants of British trade, towards the erection of which the English Government are affording foreign and distant governments assistance, more particularly by supplying the lighting apparatus, and in some cases engineering help. The expense of course is brought before Parliament in the annual votes. I may mention the Cani Rocks off Tunis, and three lighthouses now in course of erection by the Egyptian Government in the Red Sea. There are also certain other lighthouses for which the Board of Trade have supplied or are supplying the lighting apparatus; for instance, those in Vancouver's Island. There are also certain other colonial lighthouses contemplated; in the Bahamas.

318. Can you furnish the Commission with the names of any of the engineers who are employed at present by the Board of Trade on distant service connected with lighthouses?—The engineer employed on the Red Sea lighthouses is Mr. Parkes, a pupil of Mr. Walker, who was recommended by him to the Board of Trade as the resident engineer for the erection of the Cerigo Lighthouse, who subsequently worked for the East Indian Government at Kurrachee, and is now in the Red Sea, superintending the commencement of the three lighthouses there. He made the original plans and estimates in the case of the Red Sea lighthouses. The Cerigo Lighthouse was built according to the plans of Mr. Walker, the Trinity House engineer. The Great Isaacs Lighthouse was planned by the Admiralty, the Cay Lobos Lighthouse

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by Mr. Gordon. Both these works were very satisfactorily carried on by Mr. Scott, C.E., as resident engineer under Mr. Gordon. He has just come home. Mr. Harvey, the colonial engineer, will probably be employed in constructing any further lighthouses in the Bahamas. At the Cape of Good Hope Mr. Cousens is employed as clerk of the works under Mr. Gordon to carry out Mr. Gordon's plans for the Roman Rocks and Cape Point lighthouses.

319. (*Mr. Graves.*) In giving orders for the lighting apparatus for a lighthouse to be erected out of the Imperial funds, who is it in your department who submits plans and specifications for the inspection of the parties who make the tenders?—The plans and drawings are prepared by the engineer who has the conduct of the work, if the engineer is employed by the Board of Trade. In certain cases the Board of Trade have asked for the assistance of the Trinity House, and then plans are prepared in the same manner in which the ordinary Trinity House plans are prepared. In all cases the apparatus is inspected by Professor Faraday before it is finally accepted.

320. Has the illuminating apparatus for the colonial lighthouses been generally supplied by one firm, or have several firms contributed to the supply of the apparatus?—As a general principle, the Board of Trade have been anxious to obtain as much competition as possible, and they have required tenders from the three or four firms which make this apparatus. On particular occasions, where time has pressed, or where there have been other special reasons, they have been content to go to one of the known makers, the prices being pretty well ascertained, and the lowest price for similar apparatus obtained on some previous occasion being taken as a guide.

321. In the case of the lighting apparatus required for the Red Sea lights, was it publicly advertised for?—We never advertise for lighting apparatus, because there are only four or five firms in the world that make the apparatus, but we send the specifications to those firms, and get tenders from them.

322. Then has the lighting apparatus been supplied by one or other of these well-known makers?—I think it has all been supplied by one or other of those makers.

323. In purchasing oil and stores for the illumination of a colonial lighthouse, do you invite public tenders for them?—The oil, which is the principal thing, is always obtained from the Trinity House; they obtain their large supply of oil by public advertisements in the usual way, and they supply us with any quantity of oil that we want for colonial lighthouses, and then we settle accounts with them.

324. (*Captain Ryder.*) Do you find much difference in the tenders for supplying illuminating apparatus which are sent in by those two or three firms of which you have spoken?—The best way of answering this question will be to put in a paper showing the amounts of the several tenders for lanterns and lighting apparatus in a few recent cases. There was one curious case in which one of the Lighthouse Boards pressed the Board of Trade to allow a certain maker to have the contract at the price of 1,527*l.* without competition. The Board of Trade insisted on competition. Six firms were invited to tender, and the same maker who had previously asked 1,527*l.* sent in the lowest tender and obtained the contract at the price of 1,382*l.*, thus illustrating the importance of such competition as is practicable. (*The witness here put in the paper marked B.*)

325. Is it not probable when the competition is so limited that there may be an understanding between those firms as to the prices which they shall fix?—I should think it probable, judging *a priori*.

326. (*Mr. Gladstone.*) In what shape is the specification for the illuminating apparatus for colonial lighthouses drawn up?—I can furnish the Commissioners with a specimen.

327. What is the course pursued by the Board of Trade in ordering the lenticular illuminating apparatus for a new site from the manufacturers; and will you have the goodness to furnish the Commissioners with copies of the plans and specifications, &c. actually

submitted to the manufacturers in ordering the last two sets of lenticular apparatus, of a large size, or of peculiar forms, which have been purchased?—I will put in four specifications for dioptric lights apparatus; viz., for Lobos Cay, by Mr. Gordon, and for the three lighthouses in the Red Sea by Mr. Parkes. (*The witness here put in the papers marked C.*)

328. (*Mr. Graves.*) Can you state the gross annual amount voted by Parliament during the past five years for the erection of colonial lighthouses, including grants to foreign governments for lighthouses?—I put this in. (*The witness here put in the printed estimates marked D.*)

329. Can you also state the amount of dues levied for colonial lights erected under the Merchant Shipping Amendment Act of 1855?—Cape Race is the only case in which dues have been levied.

330. Is the amount received at Cape Race sufficiently large to lead to a greater extension of the system of levying tolls?—There is a good deal to be said pro and con in that matter. On the one hand, if the shipping pay for a light there will be greater facilities on the part of the Home Government in getting the necessary lights erected; and the question whether the shipping interest is willing to pay is a good test of the real utility of a light. On the other hand, there are not many places in the colonies in which such a system can be applied without the objection that the tax so taken is a tax upon trade to British ports, which does not fall upon the trade to foreign ports.

331. (*Mr. Graves.*) It has come to the knowledge of this Commission that in the matter of colouring buoys the Board of Trade has overruled the opinions of the Ballast Board; will you point out the section in the Merchant Shipping Act under which this control is exercised?—I presume it must be under either the 406th or the 408th section of the Act. The action of the Board of Trade generally arises where there is a difference between the Trinity House generally and the Scotch or Irish Board, and I believe has only been exercised in such cases.

332. (*Chairman.*) I understand you to say that it is only where a difference of opinion exists between the Scotch and Irish Boards and the Trinity House that the action of the Board of Trade arises; but I think it would appear from the correspondence furnished to this Commission that in the matter of lighting the passage between Islay and Colonsay the Board of Trade did insist upon a certain description of light, while the Trinity House had concurred with the Scotch Board in objecting to that light which the Board of Trade determined should be exhibited?—I believe that there may in some cases have been an irregularity in the mode of conducting the correspondence between the Boards, but I believe it will be found that in the end the Board of Trade have never insisted upon any opinion on a nautical question as against the Scotch or Irish Boards, unless with the concurrence of the Elder Brethren. I should add that the letter of the Act does, I believe, in some cases enable them to overrule both the Trinity House and the Scotch or Irish Boards.

333. Practically, do you make any distinction in the controlling power of the Board of Trade over the Trinity House as against the Scotch and Irish Boards?—We consider that in the case of the Trinity House the question for the Board of Trade is simply a financial question. In the case of the two other Boards the Board of Trade may have, and often has, a nautical control as well as a financial control.

334. (*Chairman.*) Then why do you consider it necessary that a more specific control should be exercised over the Scotch and Irish Boards, and a control other than that of financial?—In the first place, so it is in the Act of Parliament. The reason for putting it so in the Act probably was that in the Scotch Board they have no nautical knowledge or experience; and in the Irish Board the nautical knowledge and experience is very inferior nautical knowledge and experience to that of the Elder Brethren of the Trinity House.

335. (*Captain Ryder.*) Must not the financial control of which you speak, as the only control over the Trinity House, often become a nautical control?—Mr. Milner Gibson has stated that it is very difficult to know where the power of the purse ends. The line can only be drawn satisfactorily, by a certain amount of discretion, good sense, and forbearance on the part of those who are intrusted with this power.

336. (*Mr. Graves.*) Financially speaking, is the controlling power over the three Boards exercised precisely in the same manner with regard to the approval of expenditure?—In precisely the same manner.

337. (*Chairman.*) Does it extend to all particulars, the smallest as well as the greatest?—The smallest as well as the greatest.

338. (*Mr. Graves.*) What is the course adopted for the purpose of obtaining the sanction of the Board of Trade to any expenditure?—There is an annual estimate, which contains all the items of current expenditure, and when this estimate is approved there is no occasion to come to the Board of Trade again for approval of the separate items, except in the case of new works or very extensive repairs, in which case the Board of Trade requires special plans and estimates before the work is undertaken. In addition the tenders are also submitted to the Board of Trade.

339. What is the course adopted with items of expenditure which must constantly occur, but which are not included in the estimate?—The case is, I think, not so common as one would imagine. Small items can almost always be included in the annual estimates, and if there is a large unforeseen expense required, such, for instance, as the immediate repair of a lighthouse, or a lightship broken adrift, the Lighthouse Boards would at once take any steps which might be immediately necessary, and would, at the same time, apply to the Board of Trade, being perfectly confident of the approval of that Board. In fact they have the power of doing this by the terms of the Act.

340. In order to elucidate the question still further, I will suppose such a case as the steam tender of the Dublin Board losing the screw of her engine; would the Board be enabled to replace that without coming to the Board of Trade to sanction the expenditure?—I am not quite sure what the letter of the law might be in such a case; practically, they would, if the case was urgent, do what was needed, and would come to the Board of Trade for the approval of that expenditure, which would be given as a matter of course.

341. (*Mr. Gladstone.*) How are men selected for appointment as lighthouse keepers in the colonial lighthouses under the Board of Trade?—It is always left, as far as possible, to the colonial government. We look to the Governor as responsible for the management of the lighthouse; the only way is to get as much local responsibility as possible.

342. Have you any means of ascertaining whether their qualifications are properly tested?—The circumstances are so few and so different that it would be impossible to apply any general rule. Where we have several lighthouses, as in the Bahamas, which is the only case, we make the Governor responsible, and appoint under him an efficient inspector, and we rely upon those two persons for the practical control of the establishment.

343. The Governor and the inspector?—Yes.

344. Did you ever send out any educated lightkeepers?—The Admiralty, before the Board of Trade had anything to do with colonial lights, sent out one to the Falkland Islands. The Board of Trade have sent out to Vancouver's Island two qualified lightkeepers. They have also in one, if not in more cases, where there was no school for instructing lightkeepers in the place, sent out efficient workmen to put up the lighting apparatus, who were bound to remain a certain time after it was completed, in order that they might give persons there instructions in the management of the light.

345. (*Chairman.*) Have you anything further to add on the subject of the functions exercised by

the Board of Trade?—I should scarcely be dealing fairly with the Commissioners if I did not say that whilst I am quite alive to the historical and other reasons for the present system, it involves a good deal of circumlocution and consequent delay. Differences of opinion are not always easy to settle where there is but one department to act, and where there are three or four to be consulted before a conclusion can be come to, the difficulties are, of course, much increased. Further, I ought to say, that the Board of Trade have in some cases found considerable difficulty in exercising their peculiar functions, viz.:—the controlling expense. Many lighthouses have been built in Scotland out of the Consolidated Light Dues, and in many, if not in most, of these cases, the Board of Trade have been of opinion that the plans were too expensive. Whether they have been right or wrong in their opinions, they have found themselves unable to enforce them to any material extent, except by withholding altogether their consent to the undertakings, which is, of course, a very serious matter.

346. (*Chairman.*) Have you any particular instance you would wish to specify?—I should be unwilling to trouble the Commissioners with the numerous long correspondences we have had with the Northern Lights Commissioners on this subject. There is, however, one case, viz., that of the Pabba Beacon, which so well illustrates this difficulty, that I will put in the correspondence (*The witness here put in the papers marked E*). The undertaking is not a large one, but the correspondence illustrates the difficulties of the subject. And I am the more anxious to put it in because the Board of Trade made a slip in the first instance, by omitting specially to call for full particulars; and because that omission led to great subsequent difficulties. The case therefore not only illustrates the difficulty of controlling expenditure, but shows how important it is for the Board of Trade, to require before a work is undertaken, the very fullest particulars of what is intended, and of the manner in which the work is to be executed. I should add with reference to Messrs. Stevenson's Letter of the 22d September, 1853, that the Board of Trade have never considered that their plans were in general carelessly made, or that they under estimated the expense. On the contrary, in their works, the actual outlay has generally been very near the estimates.

Adjourned.

A.

Paper referred to in reply to Question 312.

COPY OF MR. GORDON'S FIRST REPORT WITH DESIGNS AND ESTIMATES FOR A LIGHTHOUSE ON THE GREAT BASSES off the South-east Coast of Ceylon.

22, Fludger Street, Whitehall,

15th September, 1855.

Sir,

I HAVE now the honor to comply with the desire of the Lords of the Committee of Privy Council for Trade, conveyed to me in your letter of date 16th of July last, that I should prepare and submit plans and estimates for the lighthouse which it is proposed to erect on the Great Basses upon the south-east coast of Ceylon, and that I should consider the relative expense and advantages of stone and iron as the materials for constructing the same.

The position of the reef of rocks called the Great Basses is stated now to be 81° 31' 26" east longitude, and 6° 11' 48" north latitude. They are about eight miles off the south-east coast of Ceylon, and consist of smooth red granite.

Mr. Arrowsmith having kindly furnished me with an outline of this part of the coast of Ceylon, and position of the Great Basses, I have copied the same on drawing A.

It was reported by the hydrographer † "that compared with its present dangerous state, that important turning point of Indian navigation, will be

* Admiral Sir Fleetwood Pellew's report, 9th May 1853, and Capt. W. K. Hall, of H.M.S. "Styx."

† Admiral Sir Francis Beaufort, 13th July, 1853.

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"placed in relative security by the display of one light on the Great Bass. The main object being the land fall of vessels from the southward, those coming from the westward will see the Great Bases, and carry with them its bearing quite far enough to avoid the Little Bases. Vessels from the northward, at least during the continuance of the western monsoon, will have made the coast of Ceylon to the northwards; and during the eastern monsoon, they, as well as all vessels from the Strait and from the eastward, will run down their latitude."

The Great Bases, where it is proposed now to erect a lighthouse, are stated by the late Admiral Sir Gordon Bremer, and the late Captain Dawson of the Royal Engineers, to "consist of two small fields of red granite, each of about 60 to 70 feet in breadth, and 120 or 130 feet long, the utmost rise of which above the level of the sea is 9 to 10 feet. There is a considerable under water communication between the two, and breakers extending to the north-eastward and south-westward, in all about eight hundred yards of broken water."

"The sea, particularly from the south-westward, is broken at 50 yards distance by sunken rocks, and appears in moderate weather only to shut over the visible rocks after being thus deprived of its impetus. On the outermost or easternmost of these rocks we landed and remained nearly five hours, taking bearings and angles, and H.M.S. 'Tamar' also passed completely round them in a strong gale."

On 13th May, 1853, Commander W. K. Hall, in H.M. steamer "Styx" anchored in five fathoms, about a quarter of a mile from its north-east end under its lee, (a strong double-reefed topsail breeze blowing with a proportionate sea,) and found landing wast impossible. He pulled within 50 feet of its N.W. side, which, he says, was as close as he could "safely" approach in the cutter, and on this side any heavy stores for the erection of a lighthouse could be landed with great ease. The monsoon blows nearly along the line of the Bases, and a ship could lie in five or six fathoms; 100 yards off, and in calm weather warp close in, and with her own derrick, land them on the rock, for within 50 feet there are four fathoms of water, sand, and coral bottom."

On drawing A. is also copied Capt. W. K. Hall's sketches of the Great Bases. That officer informed the commander-in-chief that the strong weather he experienced in May (during the S.W. monsoon) clearly showed how well protected a lighthouse would be on the easternmost rock. The same officer states that in September, October, and November there is fine and smooth weather, and "in September and October little or no wind."

Captain Biden, Master Attendant at Madras, has reported that "except in bad weather and a high sea, a considerable portion of the rock is always visible, and the rise and fall of sea does not exceed three feet."

The operations for the construction of the lighthouse in his opinion safely be commenced early in October, and continued with little intermission till the end of April; and he says, "when once the outworks to protect the artificers in the construction of the basement are sufficiently raised to resist the surge of the sea during the south-west monsoon, I am of opinion that (with the aid of a suitable boat moored under the lee of the rock) the work may be successfully carried on throughout the year."

There is some disparity in the accounts of the number of rocks forming the Great Bases. The late Sir J. Gordon Bremer and the late Capt. Dawson, R.E., mentioned two rocks; Capt. Biden, from the deck of Peninsular and Oriental Steam Company's ship "Bentinek," when about one and a half miles from the rocks, sketched three rocks stretching in line from S.W. to N.E.

Capt. W. K. Hall, it will be seen, has sketched some more, and especially a low rock to the south-

ward of the largest one of the reef, which forms a good breakwater; such disparity may be accounted for by the different times and different conditions of the sea. The accompanying colored sketch B. will give a pretty correct view from the seaward showing the lighthouse of the form described, and recommended hereafter, and of the desert coast, off which it will be. Over a great part of that desert district of Ceylon the late Capt. Dawson, R.E., had travelled.

The nearest station to the Bases is Hambantotte, and that small place is about 24 miles to the west by south. To the eastward of that station, except at the Kirinde salt store, the sea coast, and for miles inland, is uninhabited.*

Mr. Arrowsmith informs me that the Kirinde or Mahagam River is said to have water at all times. Its source is in the high lands, and from this river, the mouth of which is about 15 miles from the Great Bases, the principal supply of fresh water will most probably have to be obtained.

Communication must be arranged by means of several small vessels, or one or two larger vessels, between the coast and the Great Bases, for provisions, water, and stores, when the lighthouse shall have been completed; and during the time of the construction a vessel of about 150 or 200 tons ought always to be stationed at the anchorage indicated by Capt. W. K. Hall (see drawing A.)

Point de Galle may afford every facility for hiring good and safe boats for the service; but the vessel to be anchored inside the reef during the construction of the lighthouse may be lent by the Admiralty, or it may be purchased in London for about 1,600*l.*, and sold afterwards at a fair price in India.

The reef can be reached from Point de Galle in 24 hours under easy steam,† but it is quite unnecessary to have a steamer in attendance on the lighthouse work. Vessels under canvas will be more in accordance with the nature of the work and its economy than steam can be in that part of the world, and sailing vessels will be able to make their passages between the Reef and Galle during the monsoon.

The lighthouse must be of great strength at its base to resist heavy blows of the sea. It is well to suppose the waves may equal in height the large waves of the Atlantic, which, from crest to bottom of hollow, measure perpendicularly 32 to 36 feet. It has been found at the Bishop's Rock, westward of Scilly, by Mr. Nicholas Douglas, the superintending engineer of the Bishop's Rock Lighthouse, now in construction by the Trinity House, that waves of—

8 feet number 35 in one mile and 8 per minute.

15	"	"	5 and 6	"	5	"
20	"	"	3	"	4	"

In looking about for a type of such a structure to resist the power of the sea, the lighthouses which appear best to answer the requirements of the Great Bases are the tower of Cordouan, which has stood for two centuries and a half. The tower of the Eddystone, by Smeaton, and its enlarged copies at the Bell Rock by Mr. Robert Stevenson, and at Skerryvore by Mr. Alan Stevenson, and the tower on Plymouth Breakwater by Mr. James Walker. These may be said to offer only two types; a third type, however, is seen in Martello Towers. My earliest design for lighting the Great Bases and Little Bases consisted of two towers like Martello Towers, though somewhat higher in proportion.

But now that only one light is required, and that is ordered to be 120 feet above the sea on the Great Bases, which offer a site about 8 feet above water, I propose a Martello Tower as my model for stability; and remembering that the lighthouse of La Mer Sauvage at Bell Isle is a lofty cylindrical shaft, rising out of a short cylinder of large dimensions, I have designed what is shown on drawings C. and D.

There is no pretension to architectural elegance in my design; it will suffice if we succeed in not offending the eye in that particular department. The

* See Master Attendant Steward's letter from Colombo, 1st December 1853.

† Capt. W. K. Hall, R.N.

* See report of these officers, dated 11th November, 1826.

engineer looks first for stability. The architectural difference of existing lighthouse towers for somewhat similar situations is great between the noble and highly adorned architecture of Cordouan Tower, at the mouth of the Garonne, and the unadorned, unpretending square turret of Hango-ude at the south cape of Finland, yet the shape and severe simplicity of the Finnish work is equally well suited for its purpose as the enriched architecture of Cordouan.

On drawing E. will be found the sea level shown as a datum line, and in reference to it the towers of Cordouan, Eddystone, Bell Rock, Skerryvore, Heaux de Brébat, and the lighthouse which I now design for the Great Basses.

I propose to adopt, as shown on drawing C., a cylindrical basement of masonry, surrounded by an outer case or circumvallation of cast iron two inches thick, all the flanges joining the plates being inside. This basement will be 30 feet high above the rock. The masonry inside of this cast iron shell is to be set in bitumen, worked hot and bonded to the outer circumvallation. This external cylinder and its core of masonry will have to bear the shocks of the sea when it rushes over the surface of the red granite rock on which the tower is to rest. In order to prevent salt water remaining in contact with this iron circumvallation or revêtement, I propose to put a dwarf outwork or ring, or plinth, of cast iron about two feet high round the extreme base, leaving an annular space about one foot all round the basement, and to pack that space between the ring and the main revêtement by running in hot Trinidad pitch or bitumen mixed with sand and small gravel.

In course of time (whether long or short) this cast iron ring, if found then to be softened by the salt water, or injured by boulders or wreck timber, can be repaired easily, and packed again with bitumen.

From this Martello Tower is to spring the column or shaft which has to carry the light at the requisite elevation.

Drawing D. exhibits the casement as it would appear if built of pickdressed granite, all set in bitumen.

Accommodation for light-keepers will be provided in and upon the basement, which may be covered with an awning. There is also space for fresh water and for exercise at the basement. The column which rises from it will afford sufficient space for all stores and further accommodation. The diameter of the lofty column will depend upon the nature of the light, and the diameter of the lantern which contains it.

If a revolving light should be determined upon, it can be had in a diameter of 9 feet, 10 feet, 11 feet, or 12 feet. Upon these diameters of lanterns and tower upon the number of faces of reflectors, and the number of lamps and reflectors in a face, the cost of construction and annual maintenance will depend.

The illuminating apparatus should consist either of four faces or of six faces. The latter number is preferable, and the following is a calculation of times of the duration of light and darkness from four faces and from six faces, as they will be observed by seamen at the greatest distance, or in bad weather:—

With four faces.—If the full beam of light from one face of reflectors passes over 90° in $30'$, of which $16'$ are light and $74'$ are dark, the seaman will have merely $5 \cdot 3$ to set the full beam of light at a distance, and will be in comparative darkness $24 \cdot 7$.

If the light passes over 90° in $60'$ the seaman will have $10 \cdot 6$ time of the light, and $49 \cdot 4$ of darkness.

With six faces.—If the light passes over $\frac{1}{6}$ th of a circle, or 60° in $30'$, and $16'$ are light and $44'$ are dark, the seaman will have $8'$ of light and $22'$ of darkness.

If the light passes over 60° in $60'$ and $16'$ are light and $44'$ are dark, the seaman will have $16'$ and $44'$ dark.

The above remarks have reference only to revolving frames and reflectors, and their lamps, a system to be preferred to the catadioptric system of Fresnel, which is no doubt the most philosophical, and luminous silver reflectors, each having its own lamp, are more simple, however, and preferable in many respects for the remote position of the Great Basses, where the

solarly central mechanical lamp of Fresnel might be neglected, and the horizon consequently left in darkness.

The lamps for the reflectors should be in all the essential measurements the same as those which were supplied, and have answered so well, in the lighthouse which I engineered for Point de Galle. The glasses, cottons, oil, and treatment will be the same in both lighthouses.

The "four faces" above mentioned may be made with only one lamp on each face, or with two lamps, or with three lamps on each face.

The "six faces" above mentioned may also be made with one, two, or three reflectors on a face. Each reflector requires one pint of cocoa nut oil per night, so that with "six faces" of three reflectors each, the consumption will be 18 pints of oil per night, the cost of which will not exceed in all $3s$ a night.

Drawing F gives an enlarged view of such a lantern and light apparatus as I prefer for this lighthouse. With these, the light, when made out on the extreme horizon, or in thick weather, will appear alternately very bright and dark in the times stated above. In very clear weather three naked flames, i.e., their mere radiating light will be seen as a constant light at a distance of six or seven miles, varied in the times stated above on page 11 by the very bright beams of reflected light.

I am desirous to take into consideration the relative expense and advantages of stone and iron as materials for the construction of this lighthouse tower.

The general comparative values of different materials for the construction of lighthouses in the colonies are particularly stated in the letter which I had the honor to address to you, of date 26 July last, by order of Lord Stanley of Alderley, in that letter I beg to refer.

For the proposed lighthouse on the Great Basses we shall now specially consider the relative advantages and expense of iron and masonry, including in the latter both stone and brickwork, as they can be constructed on that rock.

If we refer to the Madras Lighthouse Tower constructed by Major J. T. Smith of the Madras Engineers, we shall find that at similar prices, and with similar abilities of the masons, we could not construct a suitable lighthouse tower even under the most favourable circumstances at the Basses in less than five or six years of time, and at a cost of about 19,000*l*.

The construction of the Madras Lighthouse occupied five years and five months, and Major Smith informs us that "the use of stone greatly added to the difficulties and delay of the work, owing to the limited number of stone cutters procurable for employment at the building, and the constant dis-appointments in the supply of the materials owing to the quarries being at a distance." In another place he speaks of the great delay in procuring, finishing, and fitting the granite stones facing the pedestal. He adds also that "under the most favourable circumstances, only between three and four courses of stone were completed in a single month, and in spite of all the pains which could be taken the natives inserted and fixed (certain iron clamps) so inefficiently, that they could in fact be of but little real benefit."

Such being the difficulty and delay of constructing a well-dressed granite building, with all the immediate convenience of Madras itself, the probabilities of constructing of granite a lighthouse on the Great Basses, where it will be subject to heavy blows from the sea, not experienced by the Madras one, would be vastly greater. The Great Basses are 16 miles from any fresh water, they are upwards of 50 miles from Matura, whence lime would have to be brought; they are 26 miles from Hambantotte, the nearest settlement on the coast from which any assistance could be got. A granite quarry would have to be sought out and opened, and the dressed stones transported a great distance, and if the S. W. monsoon set in whilst the work on the rock was green great loss would ensue.

The best granite would have to be carried by sea from Dondra Head, which is upwards of 50 miles

T. H. Farrer,
Esq.
13 Dec. 1860.

T. H. Farrer, Esq. distant. All the adjoining coast of Ceylon from Dondra Head to the eastward is an unhealthy and almost uninhabited country.

18 Dec. 1860.

To build a sufficient base on the rock with bricks and mortar alone, or even with cement would be highly injudicious.

I, therefore, prefer the tower and basement exhibited on drawing C. A granite stone basement would appear, if adopted, as shown on drawing D.

I propose to cut two concentric rings as seats for the lighthouse in the granite rock, and insert in them the two concentric cast iron towers shown on drawing C. The outer tower which will have to resist heavy blows from the sea, will be made of cast iron plates two inches thick, all flanged and bolted together in the inside, and this will be carried up 30 feet high.

As each course of plates of this tower is laid and bolted together, the interior will be filled up to the same level by the best large Ceylon bricks (12×6×4); no mortar or cement will be used, but bitumen from the island of Trinidad, mixed with an equal quantity of sharp sand, will be applied hot instead of water or other cement. The inside and outside of the iron work will be well paid over with the same, and the spaces between the iron and the brickwork will be carefully run in at every course of bricks with the same hot bituminous mixture.

The extensive use of this bitumen from the pitch lake of Trinidad in the Westminster New Bridge and various other engineering works, is now well known to engineers and its properties can be entirely relied upon.

I propose to have all the iron work of the basement well coated with a preparation of Trinidad pitch.

The outside of it to be sanded and coloured up a very light brown or dirty white.

The lofty shaft which carries the lantern will be made in plates of cast iron one inch thick, and lined with thin wrought-iron resting against the flanges of the tower by non-conductors of heat. There will be a film of air, or rather a hollow cylinder of air, of about 3½ inches thick acting as a non-conductor, and which may by the altitude of the tower be changed with great rapidity. From former experience of iron towers in hot climates, I am warranted in saying that the rooms in the shaft itself would form excellent apartments for sleeping or otherwise.

The hollow central column which will be observed in drawing C., is for the transport of oil and other lightroom stores by day, and for the descent of the moving weight of the revolving machinery by night. There will also be in this central column a leaden pipe for the conveyance of dirty water from a sink in the highest room down to the sea.

The top of the dwelling rooms in the basement will be decked over by 3-inch deck planking, rendered safe from fire by Mr. Maugham's process. This deck will form a good space for exercise. It is to be covered in almost all weathers by an awning stretched from the shaft to stanchions all round the Martello Tower.

Ventilation will be secured to these basement rooms by the ports shown on drawing C., and the ventilation will be arranged as suggested by Admiral Beechey, in such manner that one or more of these rooms may be used as a sick bay in case of cholera or fever.

On the deck part of the basement at the south-east side of the building will be placed a deck water-closet with cistern and other arrangements for cleanliness and comfort, and the rock at the base will be channelled to suit the same.

The space for accommodation in this lighthouse, drawing C. will be as great as that of Skerryvore or of Bréhat for keepers' water,* provisions, and stores.

* I propose to have a small still, by means of which to obtain freshwater for washing, and even for drinking, in cases of extremity. From each 10 lbs. of fuel carried to the lighthouse we may be assured of 100 lbs. or 10 gallons of fresh water. I have lately been making some experiments, which induce me to believe that by concentrating the sun's rays, the fuel for such distillation of water may be saved.

Over and above which we have got the decked space covered by the awning.

If my design, as shown on drawings C. and F., be adopted, the whole of the work above referred to should be made, erected, and tried in London under my immediate direction; then dismantled, shipped at the proper season, and landed part at the site, part at Point de Galle.

Whilst the work is in progress in this country the rock at the site can be prepared by the resident engineer, who will have charge of the whole work, as I have arranged in so many previous lighthouses.

My resident engineer should be sent out to Point de Galle by the Cape of Good Hope, taking with him a trammel, models and drawings for all excavation necessary on the rock, and some eye bolts, and a few ring bolts; stone cutters' tools, forge, tents, and fresh water tanks, jumping irons. The wrought iron crow's nest framing, stay chains, and refuge to be fixed on the middle of the site.

Having effected a landing on the north-east rock from a good and safe Point de Galle boat, in the fine and smooth water, the resident engineer and his party must mark out with white paint upon the rock the site, and cause eye-bolts to be sunk twelve inches into the granite, to which life lines, water tanks, &c., &c., may be made fast.

The landing place on the north-west side of the rock must have his early and special attention, and also a rude jetty formed for boats to land and embark workmen.

The same officer should take out a strong crane and erect it close to the jetty. When the lighthouse is to be shipped from this country it will be well to send part of it by the ship, of about 200 tons, above referred to at page 6, having a crew of 12 persons, including captain and mate. When she shall have arrived out the six seamen might be dismissed. If they do work at the rock for certain extra pay Cingalese or Lascars might be employed in their stead. The captain, first and second mate, carpenter, steward, and cook should remain with the vessel.

This crew and the working party on the rock, which may consist of 15 or 20 people more, should not be left without a surgeon. A young man who had seen some medical practice in the mercantile service should be engaged for the term necessary, which I estimate to be 12 or 14 months at most.

It may be well to venture here the suggestion that the resident engineer should be considered the supercargo, and have charge of everything but the working and discipline of the ship. These latter duties will, in my opinion, be best carried on by a captain who has traded in the east and has had command of a black crew.

Estimating for the proposed work is attended with some difficulty, particularly before my Lords have decided upon what amount of light is to be exhibited on this tower, and before they have decided what the basement of the tower itself is to be.

My estimates of cost are as follows:—

No. 1.—The design shown on the accompanying drawings B., C., and F., can be carried out, having a lantern 12 feet in diameter, and the light permanently exhibited, for the sum of	£	13,650 0
Add 7½ per cent. for contingencies		1,023 15
	£14,673 15s.	

No. 2.—If the light exhibited shall consist of only one light on each of four faces, as explained in page 11, the work can be executed, having a lantern 8 feet in diameter, and the light permanently shown, including contingencies for

8,500 0

No. 3.—If the light exhibited shall consist of two reflectors on each of four faces, having a lantern nine feet in diameter, the work can be executed, and the light permanently shown, including contingencies, for

9,600 0

No. 4.—If the light exhibited shall consist of three reflectors on each of four faces, having a lantern 11 feet in diameter, the work can be executed, and the light permanently shown, including contingencies for - £10,500 0

No. 5.—If the light exhibited shall be the same as stated above, No. 1. and with a stone tower, as shown in drawing D., the basement of the tower to be constructed of pick-dressed granite instead of the material referred to above at No. 1, the cost will be - 16,990 0

Add 10 per cent for contingencies 1,699 0

£18,689 0

It will be seen that estimates No. 1 and No. 5 will give the best light to the seaman. It also appears that estimate No. 1 may be executed and permanently lighted in about 18 months time, and that there is little prospect of No. 5 being executed within six years, while the latter will cost 4,000*l.* more than the former.

I venture to recommend strongly to my Lords the tower and lighting apparatus shown in drawings B., C., and F.

The detailed specification for these lighthouses are all drawn up and ready for being fairly copied out so soon as my Lords have determined which of the five schemes estimated for is to be proceeded with.

I have, &c.

(Signed) ALEXANDER GORDON.

B.

Paper referred to in reply to Question 324.

TENDERS FOR DIOPTRIC LIGHTING APPARATUS AND LANTERNS.

The names are omitted.

	Lighting Apparatus.			
	Whitby, North.	Whitby, South.	Bishops.	Needles.
	£	£	£ s.	£ s.
Messrs. A. - -	907	778	1,313 10	1,087 0
Messrs. B. - -	1,003	778	1,225 0	1,020 0
Messrs. C. - -	995	885	1,394 0	1,192 0
Messrs. D. - -	£2,028		—	—

NEEDLES.

	Lantern.		
	£	s.	d.
Messrs. A. - -	2,320	0	0
Messrs. B. - -	1,852	5	0
Messrs. C. - -	1,658	15	0
Messrs. D. - -	1,415	0	0
Messrs. E. - -	1,392	0	0
Messrs. F. - -	1,382	19	3

NORTH FORELAND.

	Lighting Apparatus.		
	£	s.	d.
Messrs. A. - -	1,018	10	0
Messrs. B. - -	1,055	0	0
Messrs. C. - -	1,165	0	0
Messrs. D. - -	1,192	0	0

ARRAN ISLANDS.

	Fixed Light.		Revolving Light.	
	Lantern.	Apparatus.	Lantern.	Apparatus.
Messrs. A. - -	850	1,150 0	850	1,550
Additional if with holophotal annular prisms - -	—	—	—	125
Messrs. B. - -	816	1,252 15	816	1,609
Additional if with holophotal annular prisms - -	—	—	—	152

ROCKABILL.

	Lighting Apparatus.		Lantern.	
	£	s.	£	s.
Messrs. A. - -	1,997	0	1,157	13
Messrs. B. - -	2,460	0	1,095	0
Messrs. C. - -	2,190	0	1,160	0
Messrs. D. - -	1,909	0	1,225	0

TORY ISLAND.

	Lighting Apparatus.		Lantern.	
	£	s.	d.	
Messrs. A. - -	1,568	0	0	
Messrs. B. - -	1,629	0	0	
Messrs. C. - -	1,790	0	0	
Messrs. D. - -	1,890	0	0	

MACARTHUR'S HEAD.

	Lighting Apparatus.		Lantern.	
	£	s.	d.	
Messrs. A. - -	469	0	0	
Messrs. B. - -	502	15	0	

CAY LOBOS.

	Lantern.		Apparatus.	
	£	s.	d.	£ s. d.
Messrs. A. - -	1,339	0	0	1,584 0 0
Messrs. B. - -	1,210	0	0	—
Messrs. C. - -	1,720	0	0	—
Messrs. D. - -	1,163	10	6	1,963 5 6
Messrs. E. - -	1,384	0	0	—
Messrs. F. - -	1,397	0	0	1,746 0 0

DUNGENESS.*

	Lantern.		Lantern.	
	£	s.	d.	
Messrs. A. - -	1,199	14	10	
Messrs. B. - -	1,511	0	0	
Messrs. C. - -	1,670	0	0	

*In this case the old lantern was to become the property of the contractor.

C.

Paper referred to in reply to Question 327.

LOBOS CAY LIGHTHOUSE, BAHAMAS.

Specification of Lighting Apparatus and Lamps required for the Lobos Cay Lighthouse being for a fixed catadioptric light of the size and power generally known as the first order of Fresnel's system.

Catadioptric Apparatus.

The lighting apparatus is to be for a fixed light to illuminate 360 degrees, and is to be composed of eight cylindrical lenticular panels of glass refractors, forming a circular figure, in the centre of which the concentric wick lamp is to be placed. Eight catadioptric panels, in the shape of a cupola, placed above the said cylindrical lenticular panels, and eight catadioptric panels placed below the same lenticular cylinder, forming a cylindrical figure with necessary opening portion for the attendant.

T. H. Farrer,
Esq.
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The whole apparatus is to be mounted in a brass or gun-metal frame and supported by a cast-iron column with a table or pillar placed in centre of both the lenticulated system and the lantern.

Lamps with Concentric Wicks.

There are to be provided ten four-wick lamps all exactly alike in shape and in every particular of the most improved construction, so that in the event of one getting out of order at any time, there may be but little delay in replacing it by another.

Service Gallery.

There is to be provided a cast-iron service gallery or cast-iron stage or platform fitted inside just below the level of the glass of the lantern round the catadioptric apparatus for the purpose of affording easy access to the outside of the lenticulated apparatus.

Fittings and Stores.

The contractor is also to provide the following stores, &c.:

- | | |
|--|--|
| 150 chimney glasses for the four-wick lamp. | |
| 120 feet of wicks of each of the four numbers. | |
| 6 50-gallon oil cans | Each can to be fitted with a strong gun-metal cock with a strong screwed bush, which bush is to be firmly soldered to the can. |
| 4 30 " " | |
| 1 1 " filler | |
| 2 1-quart " | |
| 2 drainers for oil cans. | |
| 1 6-gallon filtering tub. | |
| 1 4-gallon oil jack. | |
| 2 lighting burners. | |
| 2 pair of chimney tongs. | |
| 6 pints spirits of wine. | |
| 1 set Fresnel's measures. | |
| 2 trimming trays. | |
| 2 trimming cans. | |
| 2 japanned store boxes. | |
| 12 lbs. of polishing powder in tin boxes. | |
| 72 lens cloths. | |
| 72 plate glass cloths. | |
| 72 fine chamois leathers. | |
| 6 pairs of trimming scissors. | |
| 2 sets mandrils. | |
| 1½ cwt. of finest cotton waste. | |
| 2 large sponges. | |

Packing.

All the parts of this lighting apparatus to be packed in good stout deal cases, and those containing the lenses to be properly lined with tin, and when packed properly soldered, so as to be air and water tight. No hay or substance that absorbs or retains moisture to be used, but all articles or stores likely to be damaged by shaking to be packed in pine shavings or pine saw dust.

Approval.

The whole of the apparatus is to be made perfect in all its materials and details of workmanship, and to be finished in the very best and most approved manner, erected and tried on the premises of the contractor to the satisfaction of Mr. Alexander Gordon, the engineer of the lighthouse, or such person as may be appointed to superintend the same.

Delivery.

The contractor to provide all packing cases and packing, and to deliver alongside in the port of London.

Payment.

One half of the price to be paid to the contractor when the engineer of the lighthouse shall report that more than half the work is completed, the other moiety to be paid when the engineer shall report that the whole contract has been completed and delivered to his satisfaction.

Time.

The time allowed for the completion and delivery is to be months from the date at which the order is given to the contractor, under a penalty of

twenty pounds for each and every week that the work shall be delayed by the contractor beyond the said allowed time of months.

(Signed) ALEXANDER GORDON.

14 July 1857.

RED SEA LIGHTHOUSES.

Specification for Lighting Apparatus.

The apparatus for the first light will be formed to illuminate 225 degrees of the circle, and be composed of five segments. Each segment will be composed of a central refractor panel, one catadioptric panel above and one below the same.

The central refractor panel will be a compound cylindrical refractor made of a central annular lens with 16 rings, eight above and eight below, the lens accurately and securely fitted in brass frames, the five panels forming a segment of a circular figure 6 feet $0\frac{1}{16}$ in. in internal diameter.

Each catadioptric panel of the upper part will be composed of 13 segments of zones, each catadioptric panel of the lower part of six segments of zones; each panel being fitted correctly in brass frames; when fitted together the height from the bottom of the lower zones to the top of the upper zones to be 9 feet $0\frac{1}{4}$ in.

The apparatus will stand upon a cast-iron column 11 inches diameter and $\frac{3}{4}$ inch thick. The top will be turned and prepared to fit the lens table, the foot prepared as may be directed to be secured to the floor.

The table will be cast in four pieces, bolted together by the flanges with a sufficient number of wrought-iron bolts. A proper opening will be made in the table to allow of access to the interior of the apparatus, and a wrought-iron step ladder formed between it and the floor of the lightroom.

Eight wrought-iron standards, with $\frac{3}{4}$ -inch screws at the bottom end, will be fitted upon the rim of the table, and secured below with ornamental gun-metal nuts. They will be connected at the top by a wrought-iron ring $1\frac{1}{2}$ " \times $\frac{3}{8}$ ", secured to the heads of the standards by $\frac{3}{8}$ " screws upon which the upper panels will rest. The centre and lower panels will rest on curved wrought-iron stays, with the ends bent to fit between the standards, to which they will be secured by $\frac{1}{2}$ -inch bolts and nuts. The tops of the upper panels will be secured by a gun-metal ring 2 ft. 3 in. diameter and $\frac{3}{8}$ in. thick, prepared for the ventilating tubes to pass through, to which the tops of the brass frames will be bolted.

Three iron stays to connect the lens table with the brackets which support the trimming stage will be provided and fitted to the table at one end, and the other end prepared to be fitted to the brackets.

Three lamps of the first order, each having four concentric wicks, as supplied to the Trinity House, will be furnished complete.

Three additional burners, each of which will fit to any of the lamps, will be furnished.

Copper ventilating tubes, on Professor Faraday's principle, will be fitted to the apparatus, to be formed of sheet copper, of $2\frac{1}{2}$ lbs. to the superficial foot.

The holophotal revolving light apparatus will consist of eight segments. Each segment will be composed of a central annular refractor one holophotal panel above and one below the same. Each holophotal panel of the upper portion to be composed of 18 zones, and of the lower portion of 8 zones, all of 3 ft. $3\frac{1}{4}$ in. focal distance.

The apparatus will be supported on a strong improved revolving machine of the best construction with guide roller pulleys, gut lines, and weight complete.

The lens table to be cast in four pieces as in the case of the fixed light, the framing to be similar so far as suitable, the top to be furnished with rollers and collar in the usual manner working in a gun metal ring firmly secured to the rafters of the lantern as may be directed.

Three lamps and burners and ventilating tubes similar to those described for the first apparatus will be furnished complete.

The second order fixed light will be formed to illuminate 360 degrees, and will consist of six segments, each segment being composed of a central refractor panel, one catadioptric panel above and one below the same.

The central refractor to consist of a central lens with 12 rings, six above and six below. The upper catadioptric portion of 12 zones, and the lower portion of five zones. The whole will be correctly fitted in brass frames, and will form when put together a circular figure 4 feet $7\frac{1}{2}$ inches internal diameter, and 7 feet high.

The apparatus will be supported upon a cast-iron column and table, and wrought-iron frame similar to that described for the first order apparatus, but of reduced dimensions proportioned to the size.

Three lamps of the second order with three burners as supplied to the Trinity House, and ventilating tubes complete will be furnished.

After the whole shall have been erected and approved, the several parts will be marked, taken down, and packed in suitable and approved cases in such manner that no package shall exceed 4 cwt. in weight. The contents and weight of each package will be furnished to the engineer.

Payment to be made on certificate of delivery.

D.

Papers referred to in reply to Question 330.

LIGHTHOUSES ABROAD.

ESTIMATES of the Sums as voted in the Years 1856 to 1860, inclusive, to defray the Cost of Erecting and Maintaining the under-mentioned Lighthouses abroad.

1856-7.

Twenty-nine thousand four hundred Pounds.

Services.	Year 1856, ending 31 March 1857.
Bahamas :	
To defray the expense of maintaining the lighthouses at Abaco, Gun Cay, and Cay Sal Bank :	
Wages, three lightkeepers at 70 <i>l.</i> each - - -	210
Wages, three assistant ditto at 36 <i>l.</i> each - - -	108
Rations for keepers and assistants -	120
Oil and stores for lighting -	1,100
Repairs, boat hire, and incidentals -	638
Allowances for superintending and inspecting the lighthouses, and expenses connected therewith -	224
	2,400
Falkland Islands :	
For wages, &c. of lightkeepers -	200
For oil and stores for lighting -	400
	600
Nova Scotia :	
Contribution towards the expenses of the establishment at Sable Island, for the relief of persons shipwrecked -	400
Newfoundland :	
For the completion of the lighthouse on Cape Race - - -	1,000
Ceylon :	
To defray the expense of erecting a lighthouse at the Great Basses Rocks, on account of which a sum of 3,000 <i>l.</i> was voted last year (Explanatory Paper A., page 30) - - -	17,000
For purchase of a steamer for the carriage of materials and stores for the lighthouse - - -	*6,000
	23,000
Ionian Islands :	
To defray the expense of erecting a lighthouse on the northern point of the Island of Cerigo (Explanatory Paper B., page 30) - - -	2,000
	£ 29,400

1857-8.

Thirty-seven thousand and sixty Pounds.

Service.	Estimate for the Years	
	1856.	1857.
For Maintenance of Lighthouses already erected, viz. :—	£	£
Bahamas (Abaco, Gun Cay, and Cay Sal Bank) - - -	2,400	2,460
Falkland Islands - - -	600	600
Newfoundland (Cape Race) - - -	—	600
For new works (lighthouses to be erected and in course of erection) :		
Newfoundland (Cape Race) - - -	1,000	—
Ceylon (Great Basses Rocks) - - -	23,000	8,000
Ionian Islands (Cerigo) - - -	2,000	4,000
Bahamas (Great Isaac) - - -	—	7,500
" (Cay Lobos) - - -	—	5,000
Cape of Good Hope (South Point) - - -	—	3,500
" (Roman Rocks) - - -	—	1,500
Western Australia (King George's Sound) - - -	—	3,500
For contribution towards the expenses of the establishment at Sable Island, Nova Scotia, for the relief of persons shipwrecked - - -	400	400
	£ 29,400	37,060

Board of Trade, }
April 1857. }

1858-9.

Twenty-seven thousand one hundred Pounds.

Service.	Years	
	1857.	1858.
For Maintenance of Lighthouses already erected, viz. :—	£	£
Bahamas (Abaco, Gun Cay, and Cay Sal Bank) - - -	2,460	2,600
Purchase of schooner for the use of the above lighthouses, including repairs, maintenance, &c. - - -	—	2,500
Falkland Islands (Cape Pembroke) - - -	600	600
Ionian Islands (Cerigo) - - -	—	300
Newfoundland (Cape Race) - - -	600	600
For New Works (Lighthouses to be erected and in course of erection) :		
Ceylon (Great Basses Rocks) - - -	8,000	10,000
Ionian Islands (Cerigo) - - -	4,000	—
Bahamas (Great Isaacs) - - -	7,500	2,900
" (Cay Lobos) - - -	5,000	6,500
Cape of Good Hope (South Point) - - -	3,500	—
" (Roman Rocks) - - -	1,500	—
Western Australia (King George's Sound) - - -	3,500	1,500
Miscellaneous :		
For contribution towards the expenses of the establishment at Sable Island, Nova Scotia, for the relief of persons shipwrecked - - -	400	400
Inspection of light apparatus - - -	—	100
	£37,060	27,100

Board of Trade, }
30th March, 1858. }

1859-60.

T. H. Farrer,
Esq.

18 Dec. 1860.

Thirty-six thousand seven hundred Pounds.

Service.	Years	
	1868.	1859.
For Maintenance of Lighthouses already erected, and of the New Lighthouses expected to be lighted during the year, viz.:-	£	£
Bahamas (Abaco, Gun Cay, Cay Sal Bank, Great Isaacs, Lobos Cay, and Lighthouse schooner) -	5,100	5,000
Falkland Islands (Cape Pembroke) -	600	600
Ionian Islands (Cerigo) -	300	300
Newfoundland (Cape Race) -	600	600
Western Australia (King George's Sound) -	1,500	600
For New Works (Lighthouses in course of erection):		
Ceylon (Great Basses Rocks) -	10,000	10,000
Bahamas (Great Isaacs) -	2,000	4,800
" (Cay Lobos) -	6,500	4,800
Cape of Good Hope (Roman Rocks)	-	2,500
British Columbia (for the erection of lighthouses in Fucas Straits and Esquimalt Harbour, Vancouver's Island) -	-	* 7,000
Miscellaneous:		
For contribution towards the expenses of the establishment at Sable Island, Nova Scotia, for the relief of persons shipwrecked -	400	400
Inspection of lighting apparatus -	100	00
	£27,100	36,700

* Of this sum 3,500*l.* is to be repaid eventually from the revenues of the colony, and the lighthouses will be maintained entirely by the colony.

1860-61

Seventeen thousand Pounds.

Service.	Total Estimates for the Years	
	1859.	1860.
For Maintenance of Lighthouses already erected, and of the New Lighthouses expected to be lighted during the year, viz.:-	£	£
Bahamas (Abaco, Gun Cay, Cay Sal Bank, Great Isaacs, Lobos Cay, and Lighthouse schooner) -	5,000	5,800
Falkland Islands (Cape Pembroke) -	600	600
Ionian Islands (Cerigo) -	300	300
Newfoundland (Cape Race) -	600	200
Western Australia (King George's Sound) -	600	600
For New Works (lighthouses in course of erection):		
Ceylon (Great Basses Rocks) -	10,000	-
Bahamas (Great Isaacs) -	4,800	-
" (Cay Lobos) -	4,800	1,000
Cape of Good Hope (Roman Rocks)	2,500	1,000
British Columbia (for the erection of lighthouses in Fucas Straits and Esquimalt Harbour, Vancouver's Island) -	7,000	-
Red Sea, three lanterns and apparatus	-	7,000
Miscellaneous:		
For contributions towards the expenses of the establishment at Sable Island, Nova Scotia, for the relief of persons shipwrecked -	400	400
Inspecting of lighting apparatus -	100	100
	36,700	17,000

In addition to the above a vote of 2,121*l.* 19*s.* 10*d.* was taken for a lantern and dioptric apparatus presented by H.M. Government to the Bey of Tunis for a lighthouse on the Cani Rocks. (See p. 9, of 202 of 1860, of Civil Contingencies.

E.

CORRESPONDENCE respecting the CONSTRUCTION of the PABBA BEACON, between the BOARD of TRADE and the COMMISSIONERS of NORTHERN LIGHTHOUSES, referred to in reply to Question 346.

Northern Lighthouse Office,
Edinburgh, 22d July 1858.

SIR, I AM directed by the Commissioners of Northern Lighthouses to transmit herewith accounts given in by Messrs. Stevenson, as per list annexed, thirteen in number, and amounting to 920*l.* 14*s.* 4*d.* These are submitted for the sanction of my Lords previous to being paid.

I am, &c.
(Signed) ALEXR. CUNNINGHAM,
Secretary.
The Secretary
Marine Department,
Board of Trade.

LIST OF ACCOUNTS REFERRED TO.

1. Miscellaneous.

Charged Abstract G., account for quarter to 31st March 1859.

	£	s.	d.
Admiralty Light list -	-	5	10 3
Indian Lighthouse -	-	10	4 9
Chart -	-	4	4 0

2. Extra Repair.

Charged Abstract A., Bell Rock, Voucher 9, quarter to 31st March 1859.

Bell Rock -	-	10	10 0
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3. Percentage on Lights furnished.

Charged Abstract L., in accounts for the quarter to 31st March 1859.

Rona -	-	102	10 0
Kyleakin -	-	102	10 0
Orousay -	-	47	10 0
Sound of Mull -	-	75	0 0
Ushenish -	-	432	10 0
Pabba Beacon -	-	27	10 0

4. Contemplated Lights.

Charged Abstract L., in accounts for the quarter ending 31st March 1859.

Holborn -	-	33	9 4
Corran -	-	13	13 0
St. Abbs -	-	55	13 0

£920 14 4

Office of Committee of Privy Council
for Trade, Marine Department,
Whitehall, 11th August 1858.

SIR, I AM directed by the Lords Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 22d ultimo, transmitting for their Lordships' sanction certain accounts of Messrs. Stevenson, amounting to nine hundred and twenty pounds fourteen shillings and fourpence (920*l.* 14*s.* 4*d.*)

My Lords direct me to observe with reference to Messrs. Stevenson's professional charges on five hundred pounds (500*l.*), the estimated cost of the Pabba Beacon works, amounting to twenty-seven pounds ten shillings (27*l.* 10*s.*), that in the letter from this department of the 24th June 1857, their Lordships approved of the erection of an iron beacon on the island of Pabba, similar in character to that on the Callackstone, and as the cost of the works according to the account which has been rendered, is only one hundred and twenty-one pounds ten

shillings (121*l.* 10*s.*), my Lords will be glad to be informed why the Commissioners are charged on the estimate for a plan not approved or carried into effect instead of an estimate for the substituted plan for it.

I am, &c.
(Signed) T. H. FARRER.

The Secretary to the
Commissioners of
Northern Lighthouses.

SIR,
Northern Lighthouse Office,
Edinburgh, 17th August 1858.
I HAVE to acknowledge the receipt of your letter of the 11th current, with some observations on the account of Messrs. Stevenson. These observations having, in the absence of the Secretary, been communicated to Messrs. Stevenson, I am now directed to forward a copy of their answers.

I am, &c.,
(Signed) ALEX. CUNNINGHAM,
Secretary.

The Secretary
Marine Department,
Board of Trade.

(Copy.)

DEAR SIR,
Edinburgh, 16th August 1858.
WE have received from you the letter of the Board of Trade of 11th August, relative to our accounts, and we now return it with the following explanations.

The beacon at Pabba was originally proposed by us to be made of stone, as there was abundance of stone on the ground, and the estimated cost was 500*l.* We were instructed, however, to prepare plans for an iron beacon on the same principle as that erected at Kyleakin, and the beacon on that principle has now been erected. It must be observed, however, that the only resemblance between the beacons at Kyleakin and Pabba is, their being both of malleable iron rods arranged on the same principle of construction. Kyleakin is on a rock which covers only about 4 feet at high water, while Pabba is on a low water rock, on which there is a rise of 15 feet, the one beacon is 20 and the other 40 feet in height. The sum of 121*l.* 10*s.* does not include the whole expenditure on Pabba, which amounts to 502*l.* 5*s.* 2*d.* Having made a preliminary sketch for a stone beacon, and afterwards full drawings for an iron one, we consider we are justified in making the charge for conducting the works on an expenditure of 500*l.*, the original estimate.

We are, &c.
(Signed) D. and T. STEVENSON.

A. Cunningham, Esq.,
&c. &c.

Office of Committee of Privy Council
for Trade, Marine Department,
Whitehall, 7th September 1858.

SIR,
I AM directed by the Lords of the Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 17th ult., enclosing a copy of a letter from Messrs. Stevenson on the subject of their charge for designing the Pabba Beacon.

In reply, I am to state for the information of the Commissioners of Northern Lighthouses, that my Lords in their letter of the 11th ultimo, stated that the sum of one hundred and twenty-one pounds (121*l.* 10*s.*) appeared by the accounts rendered to that time to have been expended in respect of the Pabba Beacon. Since the date of that letter the accounts forwarded by the Commissioners have been received; and my Lords find that charges for this beacon are contained therein amounting to three hundred and sixteen pounds eighteen shillings and seven-pence (316*l.* 18*s.* 7*d.*),

being sums expended by J. J. Cochrane, for wages, travelling, and incidental expenses.

The accounts already rendered to this Board show, therefore, that the sum of four hundred and thirty-eight pounds eight shillings and seven-pence (438*l.* 8*s.* 7*d.*) has been expended on the beacon in question, to the end of June last; and my Lords request that you will move the Commissioners to furnish them with a statement of the sums expended on this beacon subsequent to those contained in the accounts rendered; or if no payments have been made, with a statement of the liabilities incurred, in order that my Lords may have before them a detailed account of the expenditure of this beacon, which Messrs. Stevenson state in their letter amounts to five hundred and two pounds five shillings and ten-pence (502*l.* 5*s.* 2*d.*).

I am, &c.
(Signed) T. H. FARRER.
The Secretary
Commissioners of
Northern Lighthouse,
Edinburgh.

SIR,
Northern Lighthouse Office,
Edinburgh, 8th September 1858.
I AM directed by the Commissioners of Northern Lighthouses to acknowledge receipt of your letter of yesterday, stating that the expenditure on Pabba Beacon, appearing from the accounts rendered to the Board of Trade, was 438*l.* 8*s.* 7*d.*; and I am directed to state that the Commissioners have since paid out 63*l.* 16*s.* 7*d.*; these sums together make the amount 902*l.* 5*s.* 2*d.*, as stated by Mr. Stevenson.

I am, &c.
(Signed) ALEX. CUNNINGHAM.
The Secretary
Marine Department,
Board of Trade.

Office of Committee of Privy Council
for Trade, Marine Department,
Whitehall, 25th September 1858.

SIR,
I AM directed by the Lords of the Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 8th instant, on the subject of the expenditure on the Pabba Beacon, and to request that you will move the Commissioners of Northern Lighthouses to be so good as to furnish their Lordships with the further information specified below.

Enclosed is a statement of the several items of expenditure so far as my Lords are able to make it out.

The item No. 2 appears to be a charge amounting to 41*l.* 12*s.* for wages to J. Cochrane, for inspecting the progress of the work whilst at the manufacturers. This inspection appears to have lasted nearly four months, to have been paid for at the rate of 8*s.* a day, and to have cost nearly a third of the original contract price. My Lords request that the Commissioners will inform them whether it is their usual practice to allow a charge of this description. The Board of Trade are, of course, aware that in the case of buildings erected by a contractor under the superintendence of an engineer, it is customary to allow a clerk of the works; but they are not aware of any case, whether in England, Ireland, or the Colonies, where work has been made and put together on the contractor's premises for removal to erection in another place in which there has been a separate charge for an inspector present during the time for the construction of the work. In other cases, apparently similar, which have fallen under the cognizance of this Board, the responsibility of certifying that works of this description are properly executed has rested with the engineer, and no extra charge has been made by him on that account.

T. H. Farrer,
Esq.
18 Dec. 1860.

T. H. Farrer,
Esq.
18 Dec. 1860.

The item No. 3, includes, in addition to the 130*l.* which constituted the original contract price, an additional sum of 110*l.* 5*s.* 8*d.* for work done in the contractor's shop. My Lords would be glad to be informed how it happened that this work was not included in the original specification.

My Lords presume that the item No. 4, amounting to 108*l.* 12*s.* 5*d.*, is for the cost of erecting the beacon; but they request to be informed if this is the case.

The item No. 6, amounting to 63*l.* 16*s.* 7*d.*, consists of sums for which no accounts have yet been rendered. My Lords would be obliged if the Commissioners would inform them in what manner this sum has been expended.

I am, &c.
(Signed) T. H. FARRER.

The Secretary to the
Commissioners of
Northern Lighthouses,
Edinburgh.

Northern Lighthouse Office,
Edinburgh, 24 October 1858.
Sir,
I HAVE to acknowledge receipt of your letter of 25th ultimo, enclosing a classified account of the cost of Pabba Beacon, and submitting certain queries thereon. Having laid the same before the Commissioners of Northern Lighthouses, I am directed to state in reply,—

First, The qualifications required in an inspector at the erection of a beacon are of a very peculiar nature, as the execution is often a work of great difficulty, and attended with great risks. It is difficult to appreciate the value of an acquaintance with fixtures in rock and iron fitting being combined with a knowledge of boating in exposed situations. These qualifications Mr. Cochrane has proved himself to possess in an eminent degree, and to secure the services of such an individual (taken from a previous remunerating employment) the Commissioners have found it necessary to give him permanent pay. Thus Mr. Cochrane has been employed in preceding years in attending the execution of Vasa, Calceach, Loch Inver, and Stromna Beacons, the latter a work of great difficulty. In the working season of 1857 he was engaged on Stromna, and in preparations for Cairnbulg Beacon; but during the winter all beacon works are necessarily suspended, and the Commissioners are of opinion that in place of keeping the inspector idle while in their pay, it was better to find employment for him in the manufacturers' yards, where his services are by no means disadvantageous. His presence does not interfere with either the duty or responsibility of the engineers in directing the works, and had it not been that he was in the Commissioners' pay during the suspension of his active duties he would not have been there at all.

Second, The Pabba Beacon was never estimated by Messrs. Stevenson in iron; they proposed to build it of stone. My Lords directed it to be of iron, on the same principle as that designed for Calliach, and drawings were accordingly made and offers taken upon this footing, and the work was executed in terms of the drawing and offer. The situations of Calliach and Pabba were however essentially different, the latter requiring a 40-foot beacon, while the former was only 20; and after the Pabba Beacon was completed and erected in the work yard in Edinburgh, according to the original design, it was found not to be sufficiently rigid, and additional ties were ordered to be supplied till the engineers were satisfied of its rigidity. Hence the charge for extra work, which is correctly stated in Mr. Dove's account.

Third, The item No. 6, in my Lords, classified account, 63*l.* 16*s.* 7*d.*, is of the same description, and will fall to be included in the item No. 4, the cost of erecting the beacon.

The Commissioners have to add that there being no immediate prospect of additional beacon works,

Mr. Cochrane, after completing Cairnbulg and Pabba during the past season, sometime since left their employment.

I am, &c.
(Signed) ALEX. CUNNINGHAM.
Secretary.
The Secretary
Marine Department,
Board of Trade.

Office of Committee of Privy Council
for Trade, Marine Department,
Whitehall, 13th October 1858.

Sir,
I AM directed by the Lords of the Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 2d instant, relating to the expenditure in respect of the Pabba Beacon.

With reference to this subject my Lords direct me to observe that the facts of the case appear to be as follows:—

Messrs. Stevenson, in their report of November 1856, recommended a beacon to be placed in the Sound of Pabba, and estimated the cost at 500*l.* This proposal having been submitted for the sanction of the Trinity House by the Commissioners of Northern Lighthouses, a Committee of Elder Brethren (accompanied by Captain Sullivan and Mr. Stevenson) examined the place in May 1857, and stated it to be their opinion that one on a similar principle to that on the Calceackstone might be sufficient for the purpose. Mr. Stevenson, my Lords are informed, at the same time stated his opinion that the cost of a beacon to be made of iron on this principle would cost less than 200*l.*

My Lords then approved of an iron beacon, similar in character to that on the Calceackstone, instead of one of stone, as before proposed.

Specifications and a sketch of an iron beacon were then prepared by Messrs. Stevenson, and a tender for the construction of the beacon for 120*l.* was accepted. This tender did not include the erection.

It now appears that the sum expended on this beacon amounts to 502*l.* 5*s.* 3*d.*, instead of being less than 200*l.*, as my Lords hoped and supposed would be the case.

The details of the expenditure of this sum of five hundred and two pounds five shillings and three-pence (502*l.* 5*s.* 3*d.*) appear to be as follows; and if the statement is not correct, my Lords will be obliged if the Commissioners of Northern Lighthouses will correct it.

STATEMENT OF ACCOUNT.

	£	s.	d.
Paid Messrs. Stevenson, considering subject of works for rocks in Sound of Skye, correspondence, report, &c., and time assistants preparing tracings, &c.	34	13	0
Travelling and personal expenses	3	19	1
Making tracings of Skye Beacon and buoys for Trinity House and Board of Trade	1	11	6
Paid J. Cochrane wages for inspecting beacon at manufacturers, 8 <i>s.</i> per day at four months	41	12	0
Paid Mr. Dove for beacon as per contract	130	0	0
Ditto extra work in the manufacturers' shop	110	5	8
Paid wages of inspector and workmen	93	6	9
Travelling expenses of ditto	12	17	1
Incidental expenses	2	8	7
Paid Railway Company for carriage of materials	7	15	0
Further sums expended by Commissioners, but whether in respect of cost of work in the manufacturers' shop or of work on the spot in erecting the beacon, is not quite certain, as the accounts are not received, and the terms of the Commissioners' last letter are not quite clear	63	16	7
	£502	5	3

Upon this state of facts my Lords observe,—

First, That the whole cost has been a great deal more than they expected, and amounts to about the sum which Messrs. Stevenson estimated the stone beacon would cost.

Secondly, That Messrs. Stevenson's plan for the work to be done in the manufacturers' shop must have been far from complete and sufficient.

Thirdly, That a large item in the cost is for an inspector in the manufacturer's shop, whose services it appears were not necessary for the purpose of the particular work, who, however, was thus paid in order to retain him in the service of the Commissioners, and who has since left that service.

The money has now been spent, and my Lords cannot refuse to sanction the payment of Messrs. Stevenson's percentage. But they think it right to point out, for the special consideration of the Commissioners, how strongly this case illustrates the importance of having in all cases a complete estimate of the whole cost of a work carefully prepared, submitted, and sanctioned before the work is undertaken.

As regards the charge for Mr. Cochrane's attendance, my Lords think that it can hardly with propriety be said to have been incurred on account of the Pabba Beacon. They think also that no similar charge should be incurred in future cases of works of this character.

I am, &c.

(Signed) T. H. FARRER.

The Secretary to the
Commissioners of
Northern Lighthouses.

Northern Lighthouse Office,
Edinburgh, 23d December 1858.

SIR, Your letter of the 13th October, on the subject of Pabba Beacon, was duly received, and laid before the Commissioners, who referred it for explanation to Messrs. Stevenson. They have now received the observations of these gentlemen, and I am directed to enclose a copy.

I am, &c.

(Signed) ALEX. CUNNINGHAM,
Secretary.

The Secretary
Marine Department
Board of Trade.

(Copy.)

DEAR SIR, Edinburgh, 22d December, 1858.

We have to acknowledge having received from you the letter from the Board of Trade of 13th October last, relative to Pabba Beacon, and we regret that circumstances have prevented us from sooner replying to it.

We should willingly have avoided making a reply, but some of the statements regarding us personally seem to us to require explanation.

The first statement which we would notice is, that wherein it is said that "this case strongly illustrates the importance of having in all cases a complete estimate of the whole cost of a work carefully prepared, submitted, and sanctioned before the work is undertaken." In the case of Pabba, as indeed in all cases, this course was followed. We prepared and submitted to the Commissioners an estimate amounting to 500*l.* for a stone beacon, which we considered the most suitable design for the locality. That design was however objected to by the Board of Trade, and we were ordered to erect a beacon of malleable iron, which has cost about 500*l.* For this beacon no estimate was either asked from us, or made by us, but it appears that a casual conversation as to its probable cost has been founded on. The letter states that "their Lordships are informed that Mr. Stevenson gave his opinion, on the late voyage with Captain Sullivan and the Elder Brethren, that a beacon of iron, made on the same principle as that

"of Calliach, would cost less than 200*l.*" Mr. Thos. Stevenson, who accompanied the deputation, has no recollection of having made such a statement with reference to Pabba, nor does it seem possible that it could have been made, seeing that the small spur beacon of Calliach, measuring only 20 feet high, and erected on a rock that almost never covers, cost 115*l.*, while Pabba Beacon is 40 feet high, and is submerged to the depth of 15 feet at high water, and much more exposed. There must, therefore, it is evident, be some misunderstanding on this point. But it is clear that any such verbal, offhand opinion, even if it were casually made in the course of general conversation, could not, and ought not to have been regarded as having any definite value, having been given in absence of plans and data, and without any arithmetical calculation whatever, and certainly without the very slightest conception that such a statement would be regarded as an official communication to be afterwards founded on.

The next point we have to notice is a complaint as to the incompleteness and insufficiency of our plans, which were furnished for the contractor to work from; and here it becomes necessary to give some explanation of the circumstances of this work, although we have already done so in our letter of 29th September. The kind or style of beacon which was adopted at Pabba differs from what is in common use, and was introduced by us several years ago, and applied at certain parts of the coast where the beacons were not exposed, and did not require to exceed about 20 feet in height. At Pabba, however, owing to the peculiarity of the site, the requisite height was 40 feet, and while we foresaw that the same principle could not be applied without extra staying or bracing, we could not tell beforehand the exact amount of bracing which might be found necessary in order to produce sufficient rigidity. We therefore considered it advisable that the contractor should make as few ties as possible in the first instance, so that when the main pillars of the beacon were framed together tie after tie could be added till the desired rigidity was obtained, and our plans and specification were framed accordingly. In this way we avoided the risk of having ties forged which might afterwards be found to be unnecessary. In fact, the structure was purely an experimental one, and the experiment was not proposed by us (as we recommended stone) but by the Board of Trade, and we state with confidence that our plans and specifications provided "completely" and "sufficiently" for the carrying out of that experiment in the most economical manner in which it could be done, which is the object of all successful engineering.

We shall only add, that we think we can, with equal confidence, refer the Commissioners to the amount of our estimates as compared to the actual cost of our works, in proof of the care with which our designs are considered and our estimates are made. Thus we find that the five new lighthouses of Rona, Ushenish, Kyleakin, Oronsay, and Sound of Mull (the accounts of which are now closed), were estimated by us at the aggregate sum of 32,000*l.*, and they have cost 30,911*l.* 15*s.* Stroma Beacon, estimated at 1,000*l.*, cost 1,191*l.* 13*s.* 10*d.*; Loch Inver Beacon, estimated at 700*l.*, cost 710*l.* 17*s.*; while the works of Uist, Whalsey, Bressay, and Canturkhead, of which the accounts are not yet quite closed, will show a no less close approximation between the first estimate and the actual cost.

The only other point in their Lordships' letter which we have to mention is that with reference to our fee of 27*l.* 10*s.* for the erection of Pabba Beacon. On this subject their Lordships state, that as "the money has now been spent, they cannot refuse to sanction the payment of Messrs. Stevenson's percentage." We regret that we cannot regard this expression, when taken in connexion with the statements which precede it, in any other light than that of censure. We are unable, however, to see in what respect such censure applies to us in the particular

T. H. Farrer,
Esq.
18 Dec. 1860.

T. H. Farrer,
Esq.

18 Dec. 1860.

case in question; and we have yet to learn that a beacon 40 feet high, erected on a low tide rock, submerged 15 feet at high water, and placed in a remote district of the highlands, can be *efficiently* constructed for a sum materially under the cost at which Pabba Beacon has been constructed.

Holding these views, we feel that we should be compromising our position and our own feelings were we to accept the fees under such a reservation as to the sanction for their payment as the letter of the Board of Trade conveys, and therefore we have respectfully to inform the Commissioners, that while that censure (which we trust has arisen from misconception of the circumstances of the case) remains unrecalled, we prefer to decline accepting our fees in connexion with the work in question.

We are, &c.

(Signed) D. and T. STEVENSON.
Alexander Cunningham, Esq.

Office of Committee of Privy Council for Trade,
Marine Department,

Sir, Whitehall, 4th January 1859.

I AM directed by the Lords of the Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 23d ultimo, transmitting copy of Messrs. Stevenson's observations on the letter from this department of the 13th October last, relating to the Pabba Beacon.

In reply, my Lords direct me to request that you will point out to the Commissioners of Northern Lighthouses, that when the sketch of the iron beacon was forwarded to the Board of Trade, with a tender for its execution for 130*l.* (which was after the survey of the place by the Elder Brethren, Capt. Sullivan, and Mr. Stevenson), no information was given to their Lordships that the sketch was an experiment, still less that such heavy expenses for additional work and inspection as have since been incurred would be required. My Lords cannot but think that the interest of the public service would have been better served had Mr. Stevenson, if he foresaw these matters, brought them to the notice of the Commissioners, and pointed out that an iron beacon would probably be as costly as the one originally proposed, more especially as all parties must have been aware that the sole ground of proposing a change was a presumed saving of expense.

I have, &c.

(Signed) T. H. FARRER.

The Secretary
Commissioners of Northern Lighthouses,
Edinburgh.

Northern Lighthouse Office,

Sir, Edinburgh, 14th January 1859.

I AM directed by the Commissioners of Northern Lighthouses to acknowledge the receipt of your letter of the 4th instant regarding the accounts for Pabba Beacon. Having communicated this to Messrs. Stevenson, I am directed to transmit a copy of their answer.

I am further directed to add, that so far back as 22d July last, Messrs. Stevenson's accounts, amounting to 920*l.* 14*s.* 4*d.*, were transmitted to my Lords. As the Commissioners now understand that Messrs. Stevenson decline to accept the percentage on this beacon, while no objection has been stated to the other accounts, the Commissioners submit that they should be returned for payment.

I am, &c.

(Signed) ALEX. CUNNINGHAM,
The Secretary, Secretary,
Marine Department,
Board of Trade.

(Copy.)

Edinburgh, 8th January 1859.

(Pabba Beacon.)

DEAR SIR,

WE have received from you the letter of 4th January from the Lords Commissioners of the Board of Trade, in answer to ours of the 23d December, regarding Pabba Beacon. It is evident that there exists to some extent a misunderstanding at the Board of Trade with reference not only to the work itself, but also to our connexion it with; and, therefore, we have again, very reluctantly, to address the Commissioners on the subject.

It is stated in the letter of the 4th January from their Lordships, that the sketch of the iron beacon was forwarded, with a tender for its execution, for 130*l.*; that sum, as the Commissioners are aware, only included the cost of the work delivered at Granton, but did not cover the additional expense of its erection, and other contingencies, which their Lordships appear to have greatly under estimated.

Their Lordships consider that it was our duty to have stated that such additional outlay would be required; but it did not occur to us to do this, seeing that the specification stipulated distinctly that the beacon was to be delivered at Granton; and it was therefore apparent on the face of the documents that additional expenditure would be requisite. We, therefore, did not make an estimate of the additional expenditure required; but, had we been called upon to do so, we could have furnished an approximate total estimate. That estimate, although our original views as to the requisite number of additional braces, and the time occupied in erection, have been somewhat exceeded, we should certainly not have stated lower than 400*l.*, being 100*l.* below our estimate for the stone beacon. But, not having been required to furnish such an estimate, the whole of the misunderstanding in the matter has followed, and for this we submit, that if blame is to be imputed at all, it certainly does not rest with us.

The additional work referred to may be divided into two compartments:

First. The additions made to the beacon before it left the contractors' workyard. These were the additional braces, amounting to 62*l.* 17*s.* 2*d.*, the application of which was consequent on the experimental nature of the structure, and was partially anticipated; also additional fixtures which were required to adapt the beacon to the rock on which it was placed. This latter alteration, which formed only the ordinary addition to a work during its progress, and included tools, templates, &c., cost 47*l.* 8*s.* 7*d.*, making the total sum for the additional works before the beacon left Edinburgh, 110*l.* 5*s.* 9*d.*

The *Second* compartment, forming the greater part of the additional outlay, embraces the carriage of the beacon to its site, and its erection thereon, and amounts to 221*l.* 15*s.* 10*d.*

In explanation of this part of the outlay, we have to state that the rock on which the beacon was placed was found to be very difficult to work, and was, moreover uncovered for only a very short time during spring tides, and part of four months was occupied in sinking the six apertures for the uprights.

In February only 14 hours work could be effected on the rock.

In March only 32 hours work could be effected on the rock.

In April only 35½ hours work could be effected on the rock, being only 3 days of 10 hours a day during these three months.

Their Lordships also seem to consider that we ought to have stated that the beacon was experimental. In answer to this we have only to say that we understood that all the parties interested were perfectly aware of the fact that the largest beacon which had up till that date been constructed by the Commissioners on that principle was the Calliach Stone, which was only 20 feet high, and that the Pabba Beacon, which was 40 feet high, placed on a tide-covered

rock, and submerged 15 feet at high water, was therefore to that extent an experimental structure. The construction alluded to was introduced by us a few years ago, and adopted with marked economy for some small beacons, with the approval of the Board of Trade, who suggested its application at Pabba also. We certainly did not anticipate that our endeavours to reduce the cost of beacons by the introduction of a new construction should have involved us in this correspondence regarding Pabba, where the new construction was substituted for the stone beacon, which we considered to be the most suitable for that locality.

However we may regret the misunderstanding which has occurred, we certainly did not create it, and we think it is not just that it should be made the ground of personal censure on us, which we regret to observe their Lordships' letters appear to convey.

We are, &c.

(Signed) D. and T. STEVENSON.

A. Cunningham, Esq.,

Secretary Northern Lighthouse Board.

Office of Committee of Privy Council for Trade,
Marine Department,
Sir, Whitehall, 20th January 1859.

I AM directed by the Lords of the Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 14th inst., on the subject of the accounts for Pabba Beacon. My Lords return the accounts which were forwarded with reference to this subject, in order that they may be settled by the Commissioners.

I am, &c.

(Signed) T. A. FARRER.

The Secretary to the
Commissioners of Northern Lighthouses.

T. H. Farrer,
Esq.

18 Dec. 1860.

Thursday, 20th December 1860.

PRESENT :

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON.

Captain ALFRED PHILLIPS RYDER, R.N.

JOHN HALL GLADSTONE, Esq.

DUNCAN DUNBAR, Esq.

SAMUEL ROBERT GRAVES, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

Rear-Admiral ROBERT GORDON (Deputy Master of the Trinity House) examined.

345. (*Chairman.*) Since what time have you been Deputy Master of the Trinity House?—Since August 1858.

346. Does it occur to you that any improvement might be made in the mode of electing the Elder Brethren?—I cannot imagine that the Board would be improved by any different mode of election from the present, as it is obviously the interest of the Elder Brethren themselves to elect men whose qualifications are known, and who are able and willing to take their share in the active duties which devolve upon them, which might not be the case if the elections depended upon influence out of doors.

347. Are you of opinion that the duties performed by an Elder Brother, during the first eight years that he is in the Examining Committee are of service, as better fitting him for a post on the Light Committee?—There is no rule that the first eight years after an Elder Brother's election, should be served in the Examining Committee; his appointment thereto being dependent upon circumstances; but that is the period that a member will usually remain, when once appointed to it. Three out of the four present members of that Committee had previously passed four years in the Committee for Lights. The experience acquired in the Examining Committee is of advantage in the future consideration of questions which may come before the Elder Brethren in other Committees, or at the Board.

348. You have stated that the experience acquired upon the Examining Committee is of advantage for the future duties of the acting Elder Brethren; do you refer more particularly to the duties, and to questions, relating to lighting, buoying, &c.?—Yes. The general knowledge and information that they get upon all questions relating to Buoyage, Beaconage, Pilotage, and the capacity of Pilots, is of importance in all the duties performed by an Elder Brother.

349. (*Captain Ryder.*) Is it possible, under the present system of nominating the Committees, that an Elder Brother, who has only lately become an Elder

Brother, may be nominated one of the Examining Committee or of the Light Committee?—Yes; because the Committees being nominated on Trinity Monday in each year, any vacancy that subsequently takes place is usually filled by the member coming in, unless there shall be strong grounds for an alteration.

350. (*Mr. Gladstone.*) Can you mention any instances of that having actually been carried into effect?—Yes; I may say that Captain Bayly, who is present, was in that position; he was placed in the Light Committee, and has remained so to the present time, and Captain Arrow also; it is the general rule.

351. (*Captain Ryder.*) Are the members of the Examining Committee and the Light Committee selected for any peculiar qualifications for the work to be done by those Committees, or in what way are they elected?—They succeed by rotation. The Deputy Chairman, who is next in seniority in the Committee, succeeds to the Chair; the Chairman leaving every year, with the exception of the Chairman of the Examining Committee, who remains two years.

352. Am I to understand you to say, that the members of the Light Committee and Examining Committee are among the youngest of the Elder Brethren, or not?—I should say that they usually are so, because they at once enter upon the most active executive duties of the Corporation, by which alone their experience can be matured.

353. (*Chairman.*) The number of acting Elder Brethren being fixed, do you consider that it would be advantageous to the interests of the Service to facilitate the retirement of the more aged amongst the Elder Brethren, so that younger members might be more rapidly admitted to the list of acting Elder Brethren?—I think it would be advantageous, although at the present moment there are no members of the Board whose opinions and unflinching judgment are of more value than those of the two eldest members of the Corporation, who alone, for some years to come, would be affected by a scheme for retirement; yet it is unjust that a man who has been actively

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engaged for 20 or 25 years should be compelled to remain in harness until his death. It is not so with the clerks of the establishment, who have the option of retirement at 60 years of age, under fixed regulations, and it is, of course, an advantage to every service that promotion should be kept up in it. I think therefore that the Elder Brethren should retire on their full salaries, after the age of 70, with the exception of the Deputy Master, for whom an allowance of five-sixths might be deemed sufficient; but if he should vacate the Chair before that age, I think he ought to be allowed to retire from the Board, as he could not well return to the general duties of the Committee any more than a captain could well again become a first lieutenant.

354. Have the recommendations of the Committee of the House of Commons of 1834 with regard to the more extended admission of naval officers into the Trinity House been adopted, and if not, can you say why?—I am not aware that the number of naval officers was specified by either of the Committees of the House of Commons. At the present moment there are two members qualified by naval service, and one other, a lieutenant in the navy, who qualified by commanding a merchant ship. I think the circumstance that a larger number of naval officers have not been elected Elder Brethren may be attributed partly to the infrequency of vacancies, and partly to the consideration that as the funds of the Corporation are provided by the merchant shipping and not by the navy, it is scarcely just to the members of the merchant service that they should be precluded from attaining the only position to which they can aspire as the result of honourable servitude in the mercantile marine of the country.

355. With respect to the present remuneration of the Elder Brethren, do you consider it adequate to all the duties they have to perform?—I consider the remuneration very inadequate to the services they are called upon to perform. The duties of the Elder Brethren have greatly increased, but not so their remuneration, which ought to be increased also. I shall be glad to answer the most searching questions on this head, as a delusion exists among many persons that although the salary of the Elder Brethren is but small, they have the means of reimbursing themselves from some other source.

356. (*Mr. Graves.*) Is there any other source of income attaching to the office of the Elder Brethren besides the 7,000*l.* chargeable to the Mercantile Marine Fund for the remuneration of the whole Board of 20?—Nothing whatever beyond the small remuneration they receive for attending and advising the judge of the Admiralty Court, which is paid by the litigating parties, and averages about 10*l.* annually. The fee is two guineas each day. Sometimes causes last over one day, but it is rare, for they are usually settled in a day. It very frequently has taken me a day or two to go into all the voluminous evidence on both sides before I went into Court to assist the judge. As Deputy Master I do not attend the Admiralty Court.

357. (*Captain Ryder.*) Are there any naval officers among the Younger Brethren eligible for election of the Elder Brethren?—Yes, several.

358. Can you furnish the Commission with a list of those who are candidates for appointment as Elder Brethren, showing how long it is since they commenced to be candidates?—Yes; it shall be sent.

The same was handed in as follows:—

5th May 1840	-	Rear-Admiral the Honourable Frederick de Ros.
7th Nov. 1843	-	Captain George Evans, R.N.
4th August 1846	-	Captain Lewis T. Jones, R.N.
1st Dec. 1846	-	Captain Bart. J. Sullivan, R.N.
28th Jan. 1851,	}	Rear-Admiral Robert FitzRoy, (an Elder Brother from July 1837 to June 1843).
date of re-admission to list of candidates.		

7th Dec. 1858	-	Captain Rich. Collinson, R.N., C.B.
6th Sept. 1859	-	Captain Samuel Gurney Creswell, R.N.
3rd April 1860	-	Captain Sherard Osborn, R.N., C.B.
1st May 1860	-	Captain Erasmus Ommaney, R.N.

359. What is the mode of electing a Younger Brother to become an Elder Brother?—He must be proposed by one member of the Board, and seconded by another, and is then elected by ballot to be placed upon the list of Candidates. The Elder Brethren are selected from this list by ballot. A candidate must have commanded a ship for four years. In the navy the rule is not so stringent as to the period. A Younger Brother becomes eligible to be elected an Elder Brother on being admitted as a Candidate.

360. (*Mr. Graves.*) Do the members of the Light Committee sit as nautical advisers in the Admiralty Court?—Yes; in turn with other members.

361. (*Mr. Dunbar.*) Does His Royal Highness the Prince Consort receive any remuneration as Master of the Trinity House?—Not one farthing.

362. Do any of the Honorary Brethren receive any remuneration?—Nothing whatever.

363. (*Mr. Graves.*) Are the honorary members ever called upon to perform any duties at the Trinity House?—They can sit and vote at the Courts as has occasionally been done.

364. It appears from a Return at page 70, that the average period which the present members of the Corporation of Trinity House have to wait on the list of Younger Brethren previously to election to Elder Brethren, is about 9 years, 3 being the shortest, and 24 the longest period: can you say whether such detention acts prejudicially or otherwise on the efficiency of the Corporation?—Such a Return is no test of the average period, because a member may be a Younger Brother, and even a Candidate for many years while he continues going to sea; but he only becomes an Eligible Candidate for election when he has ceased going to sea, and is prepared to undertake the duties of the Corporation.

365. Can you favour us with a return, showing the period that the members of the present Board had to remain from the time they became eligible to the time of their election?—A return shall be made.

The same was handed in as follows:—

Rear-Admiral Gordon, Deputy-Master about 8 years.	
Captain Weller	7 "
" Madan	5 "
" Pixley	9 "
" Farquharson	4 "
" Farrer	8 "
" Bax	11 "
" Redman	3 "
" Owen	5 "
" Pigott	3 "
" Shuttleworth	2½ "
" Drew	2 "
" Were	12 "
" Pelly	23½ "
" Close	5 "
" Fenwick	7 "
" Bayly	8 "
" Webb	3 "
" Nisbet	1 "
" Arrow	1½ "

366. In the election from Younger to Elder Brethren, is there any limitation of age?—Not by statute or rule; but by practice a candidate after 50 is not likely to be elected.

367. I desire to know whether practically the election of Elder Brethren has been usually confined to ship masters sailing out of London?—Practically it has been confined to officers who have commanded ships out of London.

368. (*Mr. Dunbar.*) Have you ever had any ship masters not belonging to London as Candidates, or are there any at the present moment who are Candidates; for example, have you ever had a master from Liverpool or Glasgow, or any other outport, who desired to become a Candidate?—Yes; I believe that Captain Richard Drev came from Bristol; he was one of the Elder Brethren. Two of the present members of the Board had sailed frequently from other ports than London; and the qualification of one was partly from Liverpool and partly from London.

369. Have any persons at the outports applied to be made Younger Brethren?—Yes.

370. Can you give the number within the last 50 years?—About 30; but there is no condition as to what port a man belongs to, provided he proves his qualification as having commanded a ship.

371. (*Captain Ryder.*) What is the number of the Younger Brethren?—There is no limit as to numbers, but, as far as can be ascertained, there are now living about 180.

372. What proportion of the Younger Brethren belong to ships trading from London, and what proportion belong to ships trading from the outports?—It would appear to be in the proportion of one to five.

373. (*Chairman.*) Do any of the statutes relating to the Trinity House provide that the Younger Brethren shall be exempt from public civil duties?—Yes; under the Charter of Incorporation they are exempt from serving on juries, and from filling parochial offices.

374. Then this may in some way account for the long list of Younger Brethren?—Yes.

The following extracts from an old record of the Corporation may explain the views originally entertained upon this subject. "Exemption from land service was 'grounded on a supposition that all the members of the Corporation are by its constitution obliged to attend 'the King's service at sea for defence of the realm at 'one hour's warning.' And it is urged by Mr. Pepys, who was the first Master of the Corporation under the Charter of Confirmation of King James the First, that the number of the Younger Brethren could not be too great, that mariners are the strength of the nation, that every one has a right to be a Brother, and that if there were 4,000 it would be much more for the King's service than 400.

375. (*Captain Ryder.*) How many candidates among the Younger Brethren are there at the present moment for Elder Brethren?—59; but of these probably 40 are ineligible, either from the permanent disqualification of age, or the temporary ones of holding commands, or being in public employment, or in business as brokers.

376. (*Mr. Graves.*) Do you think it desirable that any one should be admitted to be a Younger Brother who does not mean, *bonâ fide*, to become ultimately a candidate for the office of an Elder Brother?—I see no advantage to the public service in a man who becomes a Younger Brother under those circumstances. I cannot tell what the intentions of a man may be.

377. (*Captain Ryder.*) Does the fact of the master of a merchant ship being a Younger Brother recommend him to shipowners for employment?—I do not imagine that it has any weight.

378. Are any inquiries made as to the character of men before they are nominated Younger Brethren?—No, not by the Board; it has been held that every man who has commanded a ship is entitled to become a Younger Brother.

379. (*Mr. Dunbar.*) Is it not the practice to require a good introduction from a respectable person before a man is nominated a Younger Brother?—It is the practice that the person proposing a Younger Brother should have ascertained his character.

380. He must be proposed by an Elder Brother?—Yes.

381. (*Chairman.*) Then, practically speaking, any Elder Brother before proposing a person to become a

Younger Brother satisfies himself as to his previous character and services?—Yes.

382. (*Mr. Graves.*) I think you stated that when an applicant, to be made a Younger Brother, is proved to be eligible, he has to undergo election by ballot on the part of the court?—No, not to be made a Younger Brother.

383. (*Captain Ryder.*) Has any applicant been rejected?—Never, that I remember.

384. (*Mr. Graves.*) Can you suggest any change that would lead to any improvement in the present mode of admitting Younger Brethren?—No; I do not see that any is required. It is so open to every one for admission as a Younger Brother, that I do not see that any advantage could be gained.

385. Do you consider that the open character of the admission is as likely to produce efficient applicants as if the number of the applicants was limited by annual election?—I cannot see any advantage in that.

386. (*Mr. Dunbar.*) Do you see any objection to the shipping interest through the Local Marine Boards electing a certain number of the Elder Brethren?—I consider that it would be highly prejudicial to the independence of the Corporation if any of its members were appointed as delegates from any particular ports, however great, wealthy, or important those ports might be. The Corporation holds itself aloof from all parties, politics, or local influences of every kind, and considers that its functions are to assist, protect, and forward to the utmost of the power entrusted to it the great and important maritime interests of the United Kingdom at large.

387. (*Mr. Graves.*) How many committees have practically to deal with matters relating to Lights, Buoys, and Beacons?—As committees, the Light Committee, and the Examining Committee are principally concerned; but they have no independent control without the sanction of the Board.

388. Is there not also a committee that has to deal with matters of account, revenues, &c.?—Yes; that is the Wardens.

389. (*Mr. Gladstone.*) What proportion of the time occupied by the general courts is given to the subject of Lights, Buoys, and Beacons?—That varies and must depend upon the amount of work that is before them.

390. I mean, taking it on the whole, taking the year round; is it half or the greater part of the time?—It is one very important portion of the duties; it is rather difficult to say what proportion it is, because there is never a Board that there is not something connected with Lights, Buoys, and Beacons to consider; it is the main part of the business. All these subjects are considered both in Committee and at the Board.

391. (*Chairman.*) Is there any difference between a Board and a Court?—Yes; the Courts meet monthly and the Boards weekly; the Courts must consist of 16 members, with the Master or Deputy-Master in the Chair, and they confirm the proceedings of the Boards and Committees.

392. Then those Courts are irrespective of the general Court, which is held on Trinity Monday?—Entirely so.

393. (*Captain Ryder.*) Would a shipmaster at Liverpool who applied and got made a Younger Brother be exempt from parochial duties in Liverpool?—Yes.

394. (*Mr. Graves.*) I think you said that there is no person a member of the Board, whose qualification was from the outports?—Yes, with the exceptions before named.

395. (*Captain Ryder.*) If any applications were made from the outports in the United Kingdom, would there be any objection, on the part of the Corporation, to nominate the applicants as Younger Brothers if properly recommended?—None whatever, from any port in the United Kingdom.

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*Revr. Adm.
Robert Gordon.*
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396. (*Chairman.*) I see that on the Committee for Lighthouses there are five names exclusive of that of the honorary chairman, can you say what is the average number of the members of that Committee who attend?—Every one attends constantly.

397. (*To Captain Bayly.*) You are one of the Elder Brethren of the Trinity House, and Chairman of the Light Committee?—Yes.

398. There being five members on the Light Committee, of which you are the Chairman, can you state what the average attendance at the meetings of that committee is?—I should think upon the average there are three there every day; the members are frequently away on duty; sometimes two members are away for three weeks on duty afloat.

399. (*To Admiral Gordon.*) I believe that under the Merchant Shipping Act the accounts of the Lighthouse tolls are laid before Parliament at an earlier period than they used to be before that Act came into operation. This, I conclude, must be considered as an advantage and an improvement so far. Could you inform the Commissioners generally of the benefits that have accrued to the interests of navigation, and the purposes for which sea marks and lights were intended, by the operation of those clauses of the Merchant Shipping Act, which relate to the control exercised under that Act, over the three Lighthouse Boards?—I am not aware of any benefit having resulted to the public service by placing the Trinity House under the control of the Board of Trade, beyond that of having the accounts of the Lighthouse Tolls laid before Parliament at an earlier period than they used to be; but the accounts, so far as they relate to the Trinity House, were then far more explanatory than they are at present. The ground for giving such extensive powers to the Board of Trade over the affairs of the Trinity House was, that Parliament ought to have a greater control over the Light duties, which were considered as public money; but in fact, Parliament does not now vote the money for the service of the Corporation, but only sees the Returns laid before it by the Board of Trade, who regulate the expenditure at their absolute pleasure.

400. Then supposing an act passed or a regulation made by which a return was had to the state of things as they existed when the Trinity House had the sole management of the funds, does it seem to you now, as you have had some experience as a member of the Corporation of Trinity House, and have seen the working of its machinery, that you could have proceeded gradually to diminish the Light dues?—There can be no doubt that the tolls would have been reduced under the sole management of the Corporation, when the debts which they had been obliged to incur by order of Parliament in the purchase of private lights, had been paid off. I think they would have been reduced quite as low as at present.

401. Do you consider that any greater reduction in light dues would by this time have been made by the Trinity House had they continued in the uninterrupted control and management of their funds, as was the case prior to the passing of the Merchant Shipping Act, and before the Act of 1836 which obliged them to make those costly purchases?—It is now impossible to say exactly what reductions would have been made.

402. (*Mr. Dunbar.*) Putting aside the question of charity, would you, as a Corporation, have considered yourselves justified in accumulating upwards of 300,000*l.* out of funds raised for the lights from the shipping interest?—No, certainly not.

403. Do you consider that any disadvantage has arisen to the shipping interests through the double action of the Board of Trade and the Trinity House?—The assumption of control over the expenditure, in the most trifling matters, has, I think, unnecessarily increased the details of the accounts and the correspondence between the two boards, and has

caused a greater feeling of dissatisfaction than any other subject, because the Elder Brethren were led to believe, when they acquiesced in the Merchant Shipping Act, that it was not the intention of the Board of Trade to interfere in their duties, but that their *Accounts of Income and Expenditure alone* were to pass through that department. It was, however, soon found that but few of the general duties of the Trinity House could be carried on without involving questions relating to money, of the disbursement of which the Board of Trade assumed the direction, which they exercised in a manner which I cannot but consider as frivolous and unnecessarily arbitrary, and interfering with the "management" vested in the Trinity House by the Act. I apply the terms frivolous, arbitrary, to cases like the following: On submitting a specification for a new steam vessel to the Board of Trade, they refused to sanction a double bulk head, which the Elder Brethren thought desirable, and in the specification for the cabin furniture they struck out the word "sofa," and introduced the word "seat." Secondly, on the appointment of the successor to the Buoy Keeper at the Tees, whose duties are very important in constantly watching the shifting of the sands, and as frequently removing the buoys, the Elder Brethren appointed the son of the late keeper, who had constantly assisted his father, and is a very able and intelligent young man. The Board of Trade would not sanction his appointment until after much unnecessary correspondence on the subject. On another occasion the Board of Trade "insisted" upon being furnished with some charts which had been placed in the hands of the Elder Brethren, as the private property of one of the Sub-commissioners of Pilotage at Ipswich, which of course we refused to give up, without the sanction of the owner. Again, in not only prescribing the mode in which our accounts shall be kept, but in sending an officer to inspect the method adopted for keeping them at the wharf at Blackwall. Again, moreover, in matters of Contracts, the Board of Trade require all specifications to be sent to them before tenders are invited, and they prescribe the manner and extent of the invitation; and when the tenders are received, if the Elder Brethren think it expedient not to adopt the lowest their reasons are often overruled, and even if the lowest tender is proposed for acceptance the Board of Trade still require to see all the tenders that have been sent in before any one is accepted. It requires but one step further to render the whole system ridiculous, namely, to furnish their Lordships with samples of all the various items of food, clothing, &c., they arbitrate upon. The delay thus occasioned has been stated by the contractors in some cases to be very objectionable, as the market price of an article may fluctuate considerably between the time of making the tender and that of the decision come to upon it. In one instance the Board of Trade proposed to invite tenders for the repair of the *Lyra* sailing vessel, and it was only upon a very strong remonstrance to the effect that such an arrangement had been found by shipowners to be practically disadvantageous, it being impossible to ascertain the exact amount of repair required by a vessel until she had been placed in the shipwright's hands, and her defects discovered, and that the tender consequently covered all possible contingencies—that their Lordships then consented to the work being done in the ordinary way. The result justified this course, the vessel having proved sounder when stripped than had been anticipated, and the expense consequently smaller than any contractor could have ventured to name. While on the subject of Contracts I may mention some exceptions. The Board of Trade, not anxious I presume to incur the serious responsibility attending the safety of our Lightvessels, allowed chain cables to be exceptions to the supplies by contract, and permitted the Elder Brethren to continue their practice of requiring

Messrs. Brown, Lenox, & Co. to manufacture chains for their special service of the very best material and workmanship that can be obtained, arranging the price per ton at the commencement of each year. The Board of Trade has also very recently allowed the Elder Brethren to confine their tenders for Lightvessels to a limited number of highly respectable building firms, chiefly in the River, where the work can be executed under their own and their surveyors immediate supervision. Some of these matters are, perhaps, trifles in themselves, but they indicate the power the Board of Trade assumes in our concerns, and the inconsistency of the whole proceeding, because the Elder Brethren are frequently referred to by the Board of Trade to procure Light-house works for colonial or foreign governments. This, although evincing confidence in the Elder Brethren, tells the other way as to their integrity and judgment in the management of their own concerns. In affairs of real importance, with the exception of the Godrevy Lighthouse and a pilotage case at Falmouth which is referred to in the Appendix to the Report of the Select Committee of the House of Commons on Merchant Shipping, the differences have been very few—they have not occasioned the feeling of irritation caused by the interference in minor matters, in which I consider the Board of Trade to have greatly exceeded any powers granted to them by the 422nd Sections of the Merchant Shipping Act.

404. (*Chairman.*) You have stated that the Board of Trade requires all specifications to be sent to them before tenders are invited, and that they prescribe the manner and extent of the invitation. Is it the case that the Board of Trade requires the Trinity House to furnish them with the specifications in all instances for illuminating apparatus?—Yes.

405. Is it by the Board of Trade's prescription that these specifications are framed and drawn up?—No; they do not prescribe the form of the specification.

406. Does the Board of Trade specify the names of the firms to whom invitations to tender for such apparatus are to be sent?—It has done so; but the number of firms who are supposed capable of executing the work for lighthouse purposes is very limited.

407. Can you state generally in what respect the position in which the Trinity House formerly stood to the shipping interest has been changed by the operation of the Merchant Shipping Act?—By removing it from the intermediate position which it held between the shipping interest and the Government. Before the passing of the Merchant Shipping Act no new lights were established nor tolls imposed without the previous concurrence of the trade immediately interested therein.

408. The Merchant Shipping Act would appear to necessitate the referring of all questions concerning sites of lighthouses, buoys, and beacons, their order, character, and colour, &c., to the Board of Trade, whilst the Elder Brethren have necessarily had considerable experience in such matters. Have you observed whether any and, if so, what inconvenience attends this arrangement?—I do not consider that the Board of Trade has any direct authority in such matters, excepting the inspection that is given them by the 393rd section of the Merchant Shipping Act, but the power of controlling expenditure given by clauses 422 and 423, is used as a ground of dictation as to sites, &c. for lighthouses. In most cases, however, the Board of Trade has ultimately concurred in the views of the Elder Brethren.

409. Do you consider that some modification of the interpretation which would now seem to be put upon clauses 422 and 423 of the Merchant Shipping Act which you have just mentioned, would give greater freedom to the action of the Trinity House, and enable them to confer a greater amount of benefit upon the interests under their charge in the matter of lights, buoys, and beacons?—Yes, certainly.

410. Could you point out to what extent such modification in the interpretation of those clauses would be beneficial to the interests under your charge?—The Trinity House were under the impression that those clauses limited the interference of the Board of Trade to the sanction of Estimates, but in practice the special expenditures throughout the year have to be discussed, and this minute supervision is felt to be unnecessary and attended with great inconvenience. I think that when the estimates for the year, with the fullest explanatory details that can be given, have been once submitted to and approved of by the Board of Trade, there ought to be no further question on their part, as to the mode in which the work should be executed; and the responsibility should devolve on the Elder Brethren, provided the amount does not exceed the sum estimated for. On rendering the accounts I think it would be a great saving of labour if they were transmitted to the Audit Office direct.

411. (*Mr. Dunbar.*) Do you consider that if matters relating to accounts alone were under the Board of Trade, that the action of the Trinity House in the management of Lights, Buoys, and Beacons would be more free, and more advantageously exercised for the benefit of the interests with which you are charged?—Yes; if you mean that their powers were restricted to the supervision of the correctness of our accounts, it would greatly increase our freedom of action.

412. (*Chairman.*) The Merchant Shipping Act prescribes a certain control over the Ballast Board of Dublin through the Trinity House, is that control fully exercised by the Board of Trade under that Act?—Yes.

413. Have you formed any opinion as to the effect of the working of that part of the Act?—The arrangement in force previously to the Act, was, I think, more simple and afforded sufficient control, as far as the efficiency of lighting, buoying, and beaconage goes, but we had no control over their expenditure, or their financial arrangements. Some irregularities have existed in the working of the machinery of the Act, but the proceedings are generally conducted in conformity with it.

414. You mean then that the arrangement in force previous to the Act was more simple, and afforded efficient control?—Yes; I think it did.

415. It has come to the knowledge of this Commission that the Dublin Ballast Board have no efficient steamer at their command, and that the only steamer really at their disposal is the "Midge." Are you of opinion that the Ballast Board ought to have an efficient steamer at their disposal for general service?—I consider that the Ballast Board ought to have a steamer as efficient as any one possessed by this Corporation.

416. Do you consider that the "Midge" is efficient for their work?—I do not know the "Midge," but from what has been reported to me of her size and character I think she must be wholly inefficient for the work, supposing her duties to be the same as those which are executed by the steamers employed by this Board.

417. You have stated that you think the Ballast Board ought to have an efficient steamer; what do you consider the inconveniences are of their being without one?—They must be great to the Ballast Board from the infrequency of inspections, in addition to their having no vessel to convey their stores.

418. This Commission is aware that the Ballast Board is entirely dependent, for their inspections, on the Trinity House steamers; are there no inconveniences attending this state of things?—The inconvenience to the Trinity House arises from the Western district being deprived for so long a time, of the services of its vessel, at a period of the year when she is required in London to receive the annual supplies for the District, and to distribute them amongst the

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various Light Establishments on that station. Last year one of the London vessels was obliged to supply stores for the Western District, and vessels were hired at Milford to effect the reliefs of the different light-vessels on that Station.

419. You have stated that under the Merchant Shipping Act a control is exercised, through the Trinity House, over the Ballast Board; is a similar control exercised, under that Act, over the Scotch Board?—Yes; and my remarks with respect to the operation of that control in Ireland apply generally to the Scotch Board.

420. (*Captain Ryder.*) Previously to the passing of the Merchant Shipping Act, I believe that the 6th and 7th of William the 4th, in Sections 42 and 43, Chapter 79, governed the power of the Scotch and Irish Lighthouse Boards, to erect Lighthouses; and I see, on looking at those clauses, that an appeal from the Scotch or Irish Board lay to the King in Council, in case the Trinity Board, to whom they were obliged to submit any proposal to erect a lighthouse, disapproved of their proposal; but that, if the Trinity Board approved of their proposal the erection could proceed without further interference. Under section 405 of the Merchant Shipping Act, do you understand that after the approval of the Trinity House, of the proposal to erect a lighthouse made by the Scotch or Irish Board, the Board of Trade can interfere with that proposal, and that thus an entire change has taken place in the power of the Scotch and Irish Boards, and the ultimate action of the Trinity House?—You are right as to the change of power, because it is at the discretion of the Board of Trade, whether they will allow the money for the building upon a site which they do not approve.

421. (*Mr. Gladstone.*) When there are communications between the Northern Commissioners or the Ballast Board, and the Board of Trade, respecting either the erection of new Lighthouses, the placing or alteration of buoys, or the varying of the character of a Light, do those communications always pass through the Trinity House?—Yes, they do always now.

422. (*Mr. Dunbar.*) Has there ever been an instance of the Dublin Board and the Trinity House here agreeing to anything, and the Board of Trade upsetting it?—No, I do not remember any cases at this moment, except one, which the Board of Trade considered to be of a local character, and the case of the gun for the Kish Bank Lightvessel.

423. I think you stated that they could do that if they liked?—Yes, I consider that they have the power.

424. Are the Scotch Lights erected out of the General Fund?—To the best of my knowledge they are paid out of the General Fund.

425. Is there a proposal at the present moment to erect a light on the Orkney Islands?—There is a proposal which has been before us.

426. Would that Light be erected out of the General Funds?—That would depend entirely upon whether it could be considered a General Coast Light.

427. Who would have the benefit of that light?—The vessels trading among those islands. We have not consented to its erection, because we consider the light to be of so entirely local a character as to render it doubtful whether any toll which could be imposed upon the trade that would derive benefit from it would be at all adequate to its maintenance.

428. Do the Scotch Lighthouses pay their own expenses?—Since the method of keeping accounts

has been regulated by the Board of Trade it has not been possible to determine the revenue for each light, but the Returns called for by the Commissioners for 1852 and 1858 will enable you to form some opinion. From a calculation made in 1859, founded upon the proportion of receipts of former years, it would appear that the excess of expenditure (inclusive of that for new works) over revenue in Scotland in 1858 was upwards of 32,000*l*.

429. (*Chairman.*) The case of the Godrevy Lighthouse appears to the Commissioners to be one in which, after the Trinity House and Board of Trade had concurred in the change of site to the outer rock, at or close to the danger, the Board of Trade refused its sanction, and the lighthouse was eventually erected on a site considerably within the danger; after making full allowance for the difference in the expense, if the outer site had been finally agreed on, but not forgetting that a higher toll might have been levied in respect of this lighthouse to meet that expense, are you of opinion that the determination came to by, which a lighthouse was placed on Godrevy Island was one that the Trinity House, having a due regard to all the purposes for which an expensive light had to be placed in that position, would approve, supposing their action to be altogether unfettered, and not limited as it is now by the operation of the Merchant Shipping Act?—Had the question rested solely with the Elder Brethren, the light would I think have been placed on the Outer Stone; any apparent indecision respecting building on the Stones arose from an expression of Admiral Beechey's, who had accompanied the Committee at the request of the Board of Trade, and who said, "It is no use your recommending the Stones, the Board of Trade will never sanction the expense."

430. (*Mr. Dunbar.*) After what Admiral Beechey said, did you still recommend the site of the Stones for the Lighthouse?—Yes, we did.

431. Did any correspondence take place in consequence of that?—Yes.

432. And the Board of Trade still adhered to their determination?—Yes.

433. (*Chairman.*) It is probable that the case of the Light on Rhu Vaal (Sound Islay) has come under your notice?—Yes.

434. With regard to Rhu Vaal (Sound Islay) were the Trinity House and the Board of Trade agreed as to the site and character of the light, the height of the tower, and the sailing directions or notices issued to mariners?—Yes, we were agreed as to the character of the light; the height of the tower did not come under our consideration, and, as to the sailing directions in the notice to mariners, although we do not usually interfere with such part of the duties of other Boards, on this occasion we were invited to draw them up, which we did.

435. Did the Trinity House agree with the suggestion from the Board of Trade that the light should be made to serve as a clearing mark for the Neva Rocks which are in the passage between Islay and Colonsay?—The Trinity House disapproved of opening that channel.

436. As the matter now stands, was the action of the Board of Trade, in suggesting the particular application of the light, in your opinion within the meaning of the Merchant Shipping Act?—I doubt whether it was strictly in accordance with the spirit of the Act.

Adjourned to Saturday next at halfpast eleven o'clock.

Saturday, 22d December 1860.

PRESENT :

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON,
 Captain ALFRED PHILLIPS RYDER, R.N.
 JOHN HALL GLADSTONE, Esq.
 SAMUEL ROBERT GRAVES, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

Rear-Admiral ROBERT GORDON further examined.

437. (*Chairman.*) Although it would appear from your evidence on the last day of your attendance here, that the more active and direct service connected with Lights, Buoys, and Beacons was limited to the Committee for Lights, and in some parts of it to the Examining Committee, yet I imagine that the duties on which the whole body of the Elder Brethren, although belonging to other Committees, are engaged, are more or less of that description which would add to their qualification for the executive duties that would devolve upon them when they come, in usual course, to be members of either the Light Committee or the Examining Committee. I may remark that the duties of the several Committees are stated at page 73 of the Appendix in the return to the requisition of this Commission, dated the 27th May 1859, but it might be convenient if you would repeat those duties here?—Perhaps I shall best explain by detailing to the Commissioners the duties of the separate Committees, which are as follows:—With reference to the Examining Committee, and the Committee for Lights, I may explain that as a general rule the Examining Committee, in addition to their duties as examiners into the competency of pilots, masters in the navy, and masters of other vessels in matters of pilotage, are responsible to the Board for the correctness of marks, bearings, &c., inserted in “Notices to Mariners” issued by the Trinity House. They also consider the advisability of making alterations in the position of Buoys, Beacons, or Lightvessels, whether suggested by members of the Board, or by any other persons. If their report is approved by the Board, the Light Committee, as the Executive Committee in all matters connected with Lights, Buoys, and Beacons, are directed to carry the proposed alterations into effect. In the same way the Pilotage Committee are responsible for everything connected with pilots and pilotage duties in all ports in England under the jurisdiction of the Trinity House. The Wardens control expenditure, and consider all questions of importance, alone, or in conjunction with the Committee interested in the question, as the case may be. The Supervisors of the Ballast Department regulate the important duty of raising and supplying ballast to ships, together with the management of the numerous craft required for that service, in which nearly 300 men are employed; and I am gratified in being able to say that order and good conduct is the general rule of this rough service, which has been considerably extended within a few years, in consequence of a large body of men, termed “ballast heavers,” totally unconnected with the Corporation, having claimed the protection of, and voluntarily placed themselves under the authority of the Trinity House. The Pension Committee is formed by members of other Committees, but their duties have become light since we have been prohibited from granting pensions to decayed and worn-out seamen and their families. The duties of all the Committees are purely executive. The administrative jurisdiction rests with the Board, whose sanction is required to confirm the act of any Committee beyond its ordinary routine duties.

438. What you have now stated does not go to show how much of the time of the Elder Brethren, forming the Light Committee, is employed afloat. Can you furnish the Commissioners with anything like an abstract of the number of days that each member has served afloat, from the 1st of January in this year to the present time?—I have prepared an abstract, which I will hand in.

(The same was handed in as follows):—

Number of days in which the members of the Light Committee have been afloat since the 1st of January 1860.

Captain Close	- 65 days	Chairman of the Committee until Trinity Monday.
„ Bayly	- 96 „	Chairman of the Committee to this time.
„ Pelly	- 14 „	
„ Nisbet	- 123 „	
„ Arrow	- 63 „	
„ Were	- 24 „	

439. (*Mr. Graves.*) It appears then that the members of the Light Committee are frequently absent, employed personally in superintending the removal and replacing of Buoys and Lightships, and in the monthly service of relieving crews; could not this service, to a large extent, be entrusted to a nautical superintendent as at Dublin?—I think not; one of the principles acted upon by the Elder Brethren is not to delegate to a subordinate officer the execution of any service that they consider it their duty to perform themselves; and it is a great public benefit that their numbers enable them to do this without neglecting their other duties.

440. (*Mr. Gladstone.*) Then it appears that, generally speaking, two or three of the Elder Brethren proceed to perform the duties alluded to in the previous question; do you think that those duties would not be efficiently discharged by one of the Elder Brethren?—I should say that it was always of advantage to have the judgment of two.

441. (*Chairman.*) Does the necessity of having more than one Elder Brother apply to the service of relieving the crews?—Yes. Some of the advantages attending small Committees accompanying the reliefs of the crews of Lightvessels are the following:—1. Frequent visiting and inspecting the Lightvessels and their crews, and thus affording an opportunity for immediately investigating any complaint or misunderstanding before any of the parties have left their vessel. This duty, if entrusted to any officer, would, on the receipt of his report, involve the necessity of sending another vessel with a Committee to investigate the circumstances, or to bring on shore the party complained of, thus greatly deranging the routine of the relief and increasing the expense.—2nd. Personally observing the efficiency of the Lights, and the correctness of position, and the condition of Buoys in the channels they pass through, and placing Wreck Buoys where necessary. These trips with the Reliefs also afford the Junior Members of the Examining Committee good opportunities for becoming practically acquainted with the marks for the various Buoys, and of testing the correctness of the charts as to their position. It is scarcely possible to imagine any motive except a sense of duty that could induce gentlemen to leave their homes and families for so many days together at all seasons of the year, without the slightest personal advantage accruing from it.

442. (*Mr. Gladstone.*) It appears that the expenses of the Committees of Inspection at the various stations in 1858 amounted to 821*l.* 11*s.* 7*d.*; of what did those expenses mainly consist?—Subsistence at so much per diem when afloat, and travelling expenses, and subsistence when proceeding by land, as when we went to meet the Commissioners at Whitby.

443. (*Mr. Graves.*) In answer to our requisition of the 15th February 1860, a return has been sent in, marked E, giving a detailed account of the expenditure for salaries and establishment for the years

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ending the 31st December 1857 and 1858, amounting in the latter year to 14,774l.; will you explain what is meant by "establishment," and whether the expenditure given is limited to matters relating to lights, buoys, and beacons?—The word "Establishment" in Statement E. includes the Elder Brethren, but applies to those clerks and officials only whose salaries are chargeable against Lights, Buoys, and Beacons.

444. Is the gross expenditure of the Establishment, 14,774l., all chargeable to the Mercantile Marine Fund?—14,774l. is not the gross expenditure of the Trinity House Establishment, but is that portion of the amount which is chargeable to the Lights, Buoys, and Beacons Account of the Mercantile Marine Fund.

445. (Capt. Ryder.) How is the clerk paid that is necessary for conducting the affairs of the charities and almshouses of the Corporation?—The clerks who perform the duties connected with the charities are paid exclusively from the separate income of the Corporation.

446. Do the charities of the corporation occupy much of the time of the Elder Brethren in administering them?—The almshouses are under the supervision of Elder Brethren (generally residing in the neighbourhood) who voluntarily undertake that duty.

447. Do the Elder Brethren receive any salary from the charities?—None whatever.

448. (Mr. Graves.) It appears by the detailed account of the expenditure for superannuation allowances in the year ending 1858, under the head of "official establishment," that several names are given; does that term apply solely to lights, buoys, and beacons, or does it include officials who have been connected with other duties in the establishment?—I will furnish an answer to that question.

(The same was handed in as follows):—

OFFICIAL ESTABLISHMENT.—SUPERANNUATIONS.

—	Original Appointment.	Superannuated.	Former Office.
Butterfield, C. -	1811*	1853	Accountant.
Butterfield, J. H. -	1837	1856	Collection Accounts, Examination Department.
Cole, J. W. -	1824	1855	Collector of Light Duties Office.
Cotton, B. -	1812	1855	Collector of Light Duties.
Duval, P. S. -	1824	1855	Collector of Light Duties Office.
Hall, J. -	—	1856	Surveyor of Shipping.
Herbert, J. -	1803	1856	Secretary.
Ritherdon, R. -	1837	1857	Clerk in various departments,—last in Pension Department.
White, H. A. -	1825*	1851	Fourth Clerk, (Light Committee).
Williams, W. -	1824	1855	Collector of Light Duties Office.
Hodges, T. -	1824*	1853	Head Messenger.
Parsons, W. -	—	1858	Night Watchman.
Jones, Mrs. E. -	—*	1843	Widow of Captain Jenkin Jones, R.N., an Elder Brother, drowned while on duty.
Weynton, Mrs. M. -	—*	1847	Widow of an Elder Brother, who died from illness brought on by exposure while on duty.

* These allowances were granted prior to 1st October 1853, and were accepted by the Board of Trade as chargeable on the Mercantile Marine Fund under sec. XII. of the Act 16 & 17 Viet. cap. 131.

All the above allowances were made in consideration of services in the Corporation's Official establishment, comprehending more or less of the period prior to 1853, and were accepted by the Board of Trade as within the meaning of the sections XII. and XIII. of the Act above quoted. Messrs. Cotton, Williams, and Duval were superannuated when the duties of the collection at London were transferred from the Trinity House to the Custom House. Mr. Cole's allowance was granted shortly after the completion of that arrangement.

449. At page 89 in the detailed account of the expenditure in respect of Lighthouses for the year ending 1858, there is an item for "office and house expenses," amounting to 3,467l. 17s. 5d.; can you furnish the Commissioners with a return showing the details of that expenditure?—Yes, certainly.

(The same was handed in as follows):—

OFFICE AND HOUSE EXPENSES.

Detail of Charges in 1858.

	£	s.	d.
Stationery, printing, account and minute books, gazettes, and newspapers, advertisements, and printing notices to mariners - - -	1031	7	11
Insurance - - - - -	46	10	0
Uniform clothing to messengers (6) -	43	5	0
Wages to gatekeeper, night-watchman, and domestic servants - - -	239	13	6
Tithes, water rate, and gas - - -	203	10	0
Coals, firewood, candles, oil, and coke -	158	15	9
Repairs and supplies to the house and offices - - - - -	208	16	2
Annual proportion chargeable to the Mercantile Marine Fund of expenses for board of housekeeper and domestic servants, as agreed on with Board of Trade - - -	1000	0	0
Proportion of expense of Trinity Monday Anniversary Entertainment to Her Majesty's Ministers, &c.—Annual amount agreed on in like manner -	300	0	0
Postage, carriage, and incidental charges - - - - -	199	19	0
Repair and maintenance of Pay Hall for pensioners - - - - -	36	0	1
	£3467	17	5

450. (Captain Ryder.) How many candidates for the position of Elder Brethren were there at the last two elections for Elder Brethren?—55 and 59; but I should observe, as on the last examination, that a large proportion of these were ineligible.

451. How do they give notice of their being candidates?—They request one member of the Board to propose and another to second them, upon which a ballot is taken.

452. What notice to candidates is given of a vacancy previous to election?—No public notice, as the occurrence of a vacancy is always immediately known amongst them.

453. What steps are taken by candidates to bring their peculiar claims under the notice of the Elder Brethren?—They apply personally to the Elder Brethren, and state their qualifications.

454. Do the honorary Elder Brethren, or persons unconnected with the Trinity House, take an interest in the elections, and canvass for their protégés?—Certainly not.

455. What are considered the qualifications or services which are recognized as claims for the appointment?—Having attained the rank of commander in the navy for at least four years previously, serving afloat during part of that time, or having been a master in the merchant service on foreign voyages for at least four years.

456. (Mr. Graves.) Are the steam and sailing vessels owned and employed by the Trinity House Corporation used for any other purposes besides those duties which are performed in connection with lights?—They are not employed for any other purposes.

457. I observe that the remuneration of the Trinity House engineer was changed from a system of commission to one of salary, while at the same time the mode of remunerating the engineer to the Northern Commissioners was changed from a salary to a commission; can you give the Commissioners any

reason for this change?—With respect to the Engineer to the Corporation of the Trinity House, the change was adopted to save unpleasant discussion upon minute items, but I can give no answer with reference to the Engineer to the Northern Lights.

458. Did the change originate with the Trinity House, or the Board of Trade?—It was proposed by the Trinity House, and concurred in by the Board of Trade.

459. (*Chairman.*) Will you be good enough to state exactly the course the light or toll dues now take from the period of their being received until the portion of them that is intended for the service of lights comes to the Trinity House?—The course is this: The amounts collected are remitted to the Trinity House by the collectors, daily, weekly, or monthly, according to the size of the port, and paid into the Bank of England to "The Trinity House, London, Public Account." The collections are then paid over by the Trinity House to Her Majesty's Paymaster General, to the account of the Mercantile Marine Fund, usually in sums of 10,000*l.* each. All sums for disbursements have to be imprest for. 10,000*l.* is generally asked for at a time. The applications to the Paymaster General, both to pay in and to draw out, go through the Board of Trade.

460. (*Mr. Graves.*) Suppose the Trinity House was relieved of all duties connected with the collection of light dues, and the duties of the Trinity House were confined to the simple expenditure for maintenance of lights, &c.; can you give the Commissioners any idea of the saving that would be effected in the staff of the Trinity House by such a change?—It would probably enable us to dispense with the services of five members of our official establishment, and of one supernumerary, that is to say, of 1 senior clerk, at a salary from 300*l.* to 600*l.* per annum; 4 junior clerks, 80*l.* to 200*l.* per annum; 1 supernumerary, 104*l.* per annum; the aggregate amount at the present moment being 974*l.* per annum. But on the other hand there would be the set off of superannuations upon abolition of office, &c., and so long as Light Duties are levied their collection would need to be subjected to an examination as rigid as that which it receives at our hands, involving a similar expense in some other department. The saving with us on account of books, forms, receipts, &c. would be about 200*l.* per annum.

461. Can you give the Commissioners a general opinion as to what would be the saving in the item of collection if the light dues were entirely abolished?—I can give no estimate of the saving, excepting as respects the commission allowed to the collectors of customs who collect those dues afloat, which amounted in the year ending 30th September 1860 to 1,723*l.* 8*s.* 1*d.*

462. (*Chairman.*) Then I suppose that the Custom House authorities are those who would best afford us that information?—Yes, I should think so.

463. Then your answer refers only to the collection of dues remitted to the Trinity House, and not to those collected by the Scotch or Irish Boards?—Yes, solely to those collected by the Trinity House.

464. Adverting to the question put at your last examination relative to the light at Rhu Vaal, and to the interpretation which would appear to have been put on clause 422 of the Merchant Shipping Act, as to the controlling power of the Board of Trade in that instance, and seeing that in case of a difference of opinion between the Scotch Board and the Trinity Board the Act makes the Board of Trade the ultimate referee, are you of opinion that inconvenience to the public service might arise from the power given to the Board of Trade by that Act being so interpreted?—Yes. It is not desirable that the Board of Trade, who are the ultimate referees, should interfere until appealed to; but courtesy to the naval adviser of the Board of Trade has induced the Trinity House not to decline being accompanied by him whilst employed in preliminary inspections.

465. I think that in the case of the light at Philadda the suggestion did to some extent originate with the Board of Trade?—Yes; the suggestion originated with the Board of Trade, but was concurred in by the Trinity House.

466. You are acquainted with the case of the Skervolle or Iron Rock in the Sound of Jura?—Yes, I am.

467. Then in this case the Board of Trade appears to have refused their sanction to the estimate, after the Trinity Board and Scotch Board had concurred as to the site, and after the Board of Trade had approved both the site and plans as submitted by the engineer employed by the Scotch Board; and the first letter of the correspondence sent to us is dated the 28th of March 1859, and continues till the 30th June 1859. The lighthouse has not yet been commenced. The most prominent feature in the closing letters being that the Board of Trade assert that the expense of lighthouse keepers' dwellings in Ireland is much less than that estimated for the keepers' houses for the Skervolle Rock, whilst the Northern Commissioners state that they had ascertained that the expense in Ireland in the lighthouses referred to is 18*s.* 9*d.* per square foot, while in the buildings proposed for this Scotch lighthouse it is only 13*s.* 8*d.* Does it seem to you that the action of the Board of Trade in this instance was within the meaning and intent of the Merchant Shipping Act; or, supposing that it was within the intent of the Act, do you consider such action is advantageous to the mariner's interests?—I do not consider that it was within the spirit of the Act; nor do I consider it advantageous to the interests of the mariner.

468. Do you know whether the method adopted by the Scotch Board for drawing up plans and making estimates, advertising for tenders, &c., is the same as that which is adopted at the Trinity House?—I have no cognizance of their mode of conducting those duties.

469. By clause 408 of the Merchant Shipping Act the Trinity House has power to direct the Scotch Board to proceed to erect a lighthouse in any situation; has the Trinity Board the power to adopt any one of the following courses: First, to order the Scotch Board to obtain estimates from any other than their own engineer?—No, they have not.

470. Secondly, to order their own engineer to proceed to Scotland, and make estimates, and advertise for tenders, and proceed to erect?—No.

471. Thirdly, have they any power under the Act which, if exercised, would prevent such a state of things as that, after the necessity for a lighthouse has been admitted, the plans being approved, but the estimates not being approved, a year may elapse, and the lighthouse not be commenced, because the Board of Trade will not allow the specification to be advertised, but insist upon the estimate being first lowered?—No; I do not consider that the Trinity House has any power.

472. You probably remember the question of the colour of the light to be shown in the Sound of Islay?—Yes.

473. In this case the views of the Scotch Commissioners were strongly supported by the Admiralty Surveyor, Captain Bedford, an officer of great local experience; and one of the points at issue was the colour to be shown by the light at Rhu Vaal, which the Scotch Commissioners wished to be red, as according with the directions as to colours indicating danger. The Board of Trade (the Trinity House concurring) directed the Scotch Commissioners to break through their rule on this point, and show a white light as a warning light from danger. Are you of opinion that this was an exercise of power within the meaning and intent of the Act?—As we do not consider Red to be exclusively a Danger light, I think that it was an exercise of power within the meaning and intent of the Act.

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474. Then you do not think that an enforced change of the Scotch practice is likely to lead to confusion in the mind of the mariner?—Not to a man of ordinary intelligence who paid attention to the directions issued on the subject. Similar cases exist at Scilly, where white lights are seen over the numerous dangers surrounding those islands. The light at the Monach Islands will be a Danger light, and not a leading one; and if the principle of using red only for warning lights be admitted, this light should be red, whereas the Elder Brethren have considered that its warning rays ought to be extended to the utmost possible range.

475. Are you at all acquainted with the question that arose about the character, whether it be local or general, of the light at Port Askaig and Port Gordon Coran?—Yes.

476. They appear to be cases in which there were differences of opinion as to whether the light should be considered a local or a general light; will you state what was the course adopted by the Elder Brethren previously to 1854, before they entertained the project emanating from either of the other two Boards for erecting a new lighthouse or improving the old light, showing the nature of the evidence that guided them to a decision that the application should be granted or refused?—Whatever evidence was submitted by the other Boards was carefully considered, and as a general rule the site itself was inspected. The Trinity House regarded it as within their province, in cases where the light would not be of general utility, to withhold sanction unless the expenses were defrayed from local revenues. I may, perhaps, be allowed to quote a letter addressed to the Irish Board, which had reference to a similar case:—"As respects the erection of a lighthouse on Gally Head, I am to refer to a letter from this Board, addressed to your predecessor, under date 23rd of August 1850, in which the opinion of the Elder Brethren on a like proposal was communicated to the Corporation. The Elder Brethren have carefully reviewed the whole of their proceedings on that occasion, and also the additional papers now submitted for their consideration, and they have instructed me to state that they do not feel justified in departing from the decision communicated in Mr. Herbert's letter above adverted to. They are of opinion that, having regard to the moderate distance intervening between the spheres illuminated respectively on the Head of Kinsale and that on the Fastnet Rock, and also to the general outline of the coast between the two, there does not appear, on the ground of the general navigation of passing vessels, to be any necessity for a Coast light on Gally Head. If it be intended that the proposed light should be altogether of a local character, and be maintained by a local rate, the Elder Brethren would of course offer no objection to its establishment. But, assuming that the proposal contemplates a general coast light, to be chargeable on all passing vessels, they feel bound to be guided in their opinion by the general principle which they have hitherto observed in such cases, and not to agree to increase the burden on shipping by the multiplication of lighthouses, unless those already existing in the locality are found to be so inadequate that ordinary skill and prudence on the part of mariners are considered insufficient for its safe navigation. They are of opinion that were they to disregard altogether the question of expense, and be guided solely by the consideration of what may tend to improve and to render the navigation of our coasts more easy to indifferent or incompetent navigators, they might be led to multiply the number of lighthouses on almost every portion of the coasts of the United Kingdom."

477. In the case of the light at Whalsey, with which you are probably acquainted, it appears that the Scotch Board, after suggesting a site for the lighthouse, changed their views for the reasons given, and suggested a new site, and that the Trinity House concurred in both steps: that the Board of Trade, although distinctly warned of the probable

effect of delay, namely, a claim for damage by the contractor, delayed their decision so long, that 786*l.* 15*s.* had to be paid to the contractor, in addition to his first contract, for the alleged rise in prices, &c. Are you of opinion that the action arising out of the supposed interpretation of the Merchant Shipping Act in this instance was beneficial, and that a strict adherence to the spirit of the Act had been observed in all that was done in this case?—The Trinity House concurred, for the reasons given at page 124, in the general returns to the Commission, namely, that sanction having been given by the Elder Brethren for placing the light on the Outer Bound Skerry, the Northern Commissioners (at a time of the year when inspection by the Elder Brethren was impracticable) represented the total unfitness of that site, and proposed a change to Gruna. Upon this representation, the Elder Brethren assented to the change; but on subsequently visiting the spot, they found the Bound Skerry to be in every way well adapted for building upon, and they therefore revoked their sanction to building upon Gruna, and reiterated their preference for the Outer Skerry. I am, therefore, of opinion that the power of the Board of Trade was beneficially exercised in requiring a change of site, but I know nothing of the delay which your question attributes to them.

478. In the matter of North Unst, the Northern Commissioners, in proposing a means of communication with the lighthouse, advocating either the formation of a good serviceable path, and the placing of a look-out man on the establishment, or an electric telegraph, state that the services of a boat being wanted, they proposed to retain the services of one experienced boatman, who would engage others when they were wanted. The Board of Trade reply that the Scotch Commissioners may have the wire if they will give up the experienced boatman; and this not being acceded to by the Scotch Commissioners, they refuse to allow the use of the path, and the Scotch Board decline the responsibility as to any accidents that may occur. Do you, with your experience in matters connected with lighthouses, think that there is any, and, if any, what connection between the two matters, namely, the establishing of an electric wire which has been approved of, the expense of which has been sanctioned by the Board of Trade, and the retention of the services of an experienced boatman, the necessity of which is urgently maintained by the Scotch Commissioners, who are responsible for the efficient maintenance of a safe communication with and transit to the lighthouse?—The circumstances adverted to have not in any way come under the cognizance of the Trinity House, and I should therefore decline giving an opinion on them.

479. Are you acquainted with the circumstances under which the site on which the light at North Unst is built was selected?—Yes. An application was received from the Admiralty during the Russian war, for the immediate placing of lights in that locality.

480. Are you aware that there had been any doubts or question as to the site of the light on North Unst before the Elder Brethren visited it?—Some correspondence took place. The Northern Commissioners preferred Lambness, as they did not consider it practicable to erect and maintain a Lighthouse on the Muckle Flugga.

481. Can you say whether the alteration in the site of the temporary lighthouse at North Unst was first proposed by the Trinity House, or by the Board of Trade, or by some other authority?—The question of Site was decided by us on visiting the localities. Admiral Beechey accompanied us on our inspection.

482. As regards the light on Holborn Head, in this case there is a correspondence extending from the 24th of December 1856 to the 9th of February 1860, and probably down to the present time, regarding a right of way from Scrabster Harbour to the proposed site of the lighthouse on the grounds of a Mr. Sinclair. The proposed road is to pass through Mr. Sinclair's

grounds, and he offers to make no charge for the land to be occupied by the road, provided it is a road of good construction, available for carts, &c. and he offers, in case he ever makes any use of it, to undertake the expense of maintenance as often as approved of the Scotch Commissioners. But the Board of Trade appear to expect Mr. Sinclair to give them the land over which the road is to pass for nothing. The lighthouse, urgently required and pressed for, is delayed for four years, while the Board of Trade is bargaining about the road. Has the operation of the Merchant Shipping Act, as it appears to be put in force, in this instance, been, in your opinion, a beneficial operation as regards trade, and the interests of the mariner?—I know nothing of the circumstances, and am therefore unable to answer your question.

483. In the case of the light at the Butt of Lewis, the Scotch Commissioners propose that the light should be "first order, flashing white," in order to give the greatest range possible. The Board of Trade disapprove, on the score of the expense for the apparatus (600*l.* to 700*l.* extra). The Elder Brethren select a site for another lighthouse, namely, that on Monach Islands, 70 miles from the Butt of Lewis, which is to be "flashing white," and they desire that the Butt of Lewis be a fixed light. The Scotch Commissioners represent that the illuminating of the Butt of Lewis is part of their great scheme; and that they propose to have a fixed light at Stour Head; and that, apart from the value of the light on the Butt of Lewis becoming diminished in the ratio of one to three, their plan of lighting the channels will be seriously injured, and they will be prevented from giving to Stour Head the distinctive and inexpensive character of being fixed. But they are finally overruled. What is your opinion of the working of the Merchant Shipping Act as put into opera-

Adjourned till Thursday next, at Twelve o'clock.

Thursday 27th December 1860.

PRESENT:

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON.

JOHN HALL GLADSTONE, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

Rear-Admiral ROBERT GORDON further examined.

485. (*Chairman.*) Considering the great advance in engineering skill and science, and the cases in which the greatest (apparent) natural difficulties have been overcome, as instanced in the erection of such lighthouses as the Scilly Bishop and the Snalls, &c., have the Elder Brethren come to any conclusion as to the general expediency of placing lighthouses on extreme points of danger, where possible?—Yes, as a general principle, but cases may arise in which the advantage to be derived from placing a light on the very extreme point of danger may not be sufficient to warrant a very large increase of expenditure.

486. The Commissioners are under the impression that the Ballast Board recommended that a fog signal gun should be placed on board the Kish Lightvessel, but that the Board of Trade refused its sanction on the ground of its being possibly mistaken for the gun at the South Stack. Can you say from memory whether this case was referred by the Board of Trade to the Trinity House for its opinion, and whether the Elder Brethren coincided in the grounds of the objection?—The case was referred by the Irish Board to the Trinity House, who sanctioned the gun.

487. Would it not have been according to usage and practice if the opinion of the Trinity House had been taken before the Board of Trade vetoed the recommendation of the Ballast Board?—The Board of Trade vetoed the proposition after we had concurred in it.

488. With respect to Buoyage, can you inform the Commissioners whether the expense of buoyage is an increasing item?—Yes, because buoys of improved construction and larger size are constantly being introduced.

tion in this case?—The arrangements finally determined on for the Monach and the Butt of Lewis are those deemed by the Elder Brethren to be the most expedient. The dangers surrounding the Monach group being far greater than those in the neighbourhood of the Butt of Lewis, the most efficient description of warning light was considered the fittest for the locality. No evil can accrue to vessels seeing the light at the Butt of Lewis within the ordinary range of a fixed light; and although the distance is considerable between that light and the Monach, it is important that their respective characters should be so distinctive that the mariner making the land from a long over-sea voyage should not, by any possibility, mistake them. The necessity for these important lights will probably involve an arrangement different from that contemplated, at Stour Head, which is comparatively of minor consideration. In coming to this determination the Elder Brethren took a practical view of the subject, which they think would have been concurred in by any seaman who had witnessed the low and dangerous coasts of the Monach Islands, strewn with wrecks; and in doing this, I consider that the Trinity House have acted consistently with the spirit of the Act.

484. You are aware that the French authorities have a general system of arranging the character of their lights, and the Scotch Commissioners would seem to wish to have some such system. Would an alteration in the character of the light at the Butt of Lewis disturb such a system, or is the question of a system one that has been considered?—The Butt of Lewis has never been illuminated. If we were commencing *de novo* the entire system of the illumination of our coasts, it is probable that alterations in the present character of our lights would be considered; but the practice is to place a light of the most distinctive and efficient character according to the position in which it is required.

489. Can you form any opinion as to the average annual increase of that item in the last five years?—It is difficult to give even an approximate average, of any value, because the annual expense varies considerably. Beacons are included with Buoys in the calculations, therefore the average increase in the item of Buoys alone is not readily determined. No regular annual supply of Buoys is obtained, but as the stock of any particular description is diminished it is replenished. In the last five years, new Buoys were furnished, as will appear in this paper.

The following paper was handed in:—

Wooden Buoys.	1855.	1856.	1857.	1858.	1859.
8 feet -	8	5	7	21	19
7 feet -	6	0	17	8	20
6 feet -	8	5	3	3	7
4 feet -	0	2	0	0	0
Wreck Buoys	22	3	10	12	16
Convex Base, (Poulter's), 8 feet	0	0	0	1	0
do. 9 feet	0	0	0	0	1
Flat-bottom iron Buoys (Lenox's),					
8 feet -	0	0	0	1	13
1855 { One, 6 feet spiral iron buoy.			1857 { One Patent wooden Buoy, with iron partition.		

490. I believe that the Trinity House has buoys off the Owers, off Christ Church Ledge, and off the Manacles; can you inform the Commissioners from what depot those Buoys are supplied or replaced, where they are repaired, and from what establish-

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ment or station they are watched?—The Buoys for the Owers and Christ Church Ledge are replaced from the store at East Cowes, and they are repaired at Cowes. That for the Manacles is repaired at Plymouth; they are all supplied in the first instance from Blackwall.

491. Then, if any considerable number of Buoys in the neighbourhood of East Cowes depot were added to the Trinity House charge, I conclude that they would have to be also supplied from the establishment at Blackwall in the first instance?—Yes.

492. Would the present establishment at Blackwall admit of its furnishing a greater number of buoys than it does at present with the number of workmen there employed?—The arrangements are sufficient, but it would be necessary to employ additional labour.

493. Have the Elder Brethren of the Trinity House come to any conclusion as to which is the better form and character, or in other words, the best buoy for exposed situations, where it is necessary to give the utmost possible warning to mariners, as in the case of the approaches to the Goodwin Sands, &c.?—In answer to Question 6 in the Buoy and Beacon Returns, it has been stated that for exposed channels and coasts, the Hollow Bottom Buoys, Herbert's Patent, or the large Egg Bottom Buoys, as at the back of the Goodwin, are the most approved.

494. I believe that a still larger buoy than any of those now floating at the back of the Goodwin has been proposed and even tried by the Trinity House, but is now discontinued. Can you inform the Commissioners of the reasons why no larger buoy than the largest now in use has been sanctioned?—Upon the first introduction of monster buoys, the iron ballasted buoys were the only ones known, but when improvements took place in the construction of buoys by using water ballast and hollow bottom buoys, they were found to be so superior to any other that they have been finally adopted, and although not quite so large, they are equally conspicuous, and far more manageable.

495. I suppose that a very considerable item in the expense of buoyage would be chargeable to the replacing of buoys consequent on their breaking adrift, or being damaged?—The number of buoys that break adrift, where anchored upon fair holding ground, is very few. Casualties arise from a rocky bottom, and accidents from vessels running foul of them.

496. Do you think that you have arrived at a perfect mode of securing buoys?—Yes, I think we have, with the exception I have alluded to in the case of a rocky bottom.

497. I suppose that you will be of opinion that on a coast like ours, approachable in many instances by narrow and dangerous channels, and to which such a vast amount of merchant shipping resort, the buoyage system is scarcely inferior in importance to a perfect system of lights?—In many positions it is superior, because Buoys can be placed where Lights cannot, as at the back of the Goodwin Sands, and we already find that the multiplication of Lights is so great, that it is extremely difficult to give them a distinguishing and discriminating character.

498. (*Mr. Gladstone.*) In your return to our Circular No. 5, you stated, that in buoying any single channels in future, the rule, where there are no special circumstances to require its modification, will be to place buoys of a single colour, either black or red, on the starboard side, on entering from the sea, and partly coloured buoys, either black and white, or red and white, on the port-hand, the outermost buoy on either hand being a beacon buoy if necessary, middle dangers being marked by white buoys with black beacons of various distinctive shapes. Have you carried out your plan in any instance?—We have not had occasion to fresh buoy any channel ourselves, but we have recommended the adoption of the system referred to for Lough Swilly.

499. (*Chairman.*) Are you aware whether that recommendation has been carried out?—I cannot say we have no information.

500. But you are probably aware of the correspondence between the Ballast Board, the Board of Trade, and the Trinity House on the subject of colouring the buoys in Lough Swilly, and if so, you will be aware that the Board of Trade there prescribe a mode of colouring to be adopted as regards those buoys?—Yes. I should not say that the Board of Trade prescribed the mode, although the suggestion in this particular instance emanated from them.

501. Do you consider that the meaning and intention of the Merchant Shipping Act has been rightly interpreted in the action taken in this case?—I do not consider that the question of the colour of Buoys belongs to the Board of Trade under the Act.

502. (*Mr. Gladstone.*) Do you consider it would be desirable if the uniform system now approved by you were adopted throughout the channels of the United Kingdom?—I think there are many situations in which the principle might be adopted without danger; but where the channels are intricate, or there is more than one channel, it is always a matter requiring great consideration before the colours of Buoys of long established character are altered.

503. You are aware that the Scotch system is different from that proposed by you, namely, red on the starboard and black on the port in entering, and that many of the ports and channels under the Ballast Board are buoyed on a system exactly the reverse of the Scotch, namely, red on the port and black on the starboard. What is your opinion of the fact that there are those two systems in use, in addition to the one proposed by you, and those adopted by local authorities?—I think that it is very objectionable, and that the system of having buoys of one colour upon one hand and checkered on the other is the best for single channels, as we have approved of for Lough Swilly.

504. Do you consider that you have any power to insist on the Irish or Scotch Board varying the colour or character of the buoys?—We may have the power, but have confined our interference to recommendations.

505. Do you consider that you have any such power over local authorities?—No case that I remember has arisen for calling upon us to exercise authority. With reference to local lights our authority is more defined, and we have exercised it on some occasions.

506. But by Sections 394 and 408 of the Merchant Shipping Act, you can insist on the Scotch or Irish Boards or the local authorities placing a buoy or varying the colour or character of a light. Do you know why the same power has not been given you to insist on a variation in the colour and character of a buoy?—I do not know.

507. Then am I to understand, however important you may consider it to be, that there should be uniformity in the buoyage of the channels throughout the United Kingdom, no means are provided by the Merchant Shipping Act for ensuring this uniformity?—We have never interfered with the detail of management of the duties of the Irish or Scotch Boards, excepting in special cases which have been referred to us, and should any special case arise, we should undoubtedly express our opinion upon it.

508. Do you contemplate changing the buoyage of any channels in conformity with your present system?—Not in any channel under our jurisdiction in its entire system.

509. Why do you not contemplate changing the existing buoyage of channels?—Because we consider that an entire change of system would be attended with far greater danger to navigators than the continuance of the well-known and long established character of the Buoys of any channel.

510. (*Chairman.*) You are aware that there was some correspondence between the Trinity House and the Board of Trade on the subject of the Dartmouth Beacon, I believe the Board of Trade did not approve of the Trinity House Engineer's design, and they required the substitution of one less costly?—Yes, but the question of placing a Beacon has not been

reverted to by the Trade of the Port who would be called upon to pay toll for it.

511. Then in the above case, no beacon has been placed?—No, it has not been placed.

512. Are you aware that by any reduction in the estimate for a light, a buoy, or a beacon, a less sufficient article has been placed than would have been the case if the original estimate had been adhered to?—In the case of the Anquette Beacon at Jersey a reduction in the expense and consequent size of the Beacon may to a certain extent have affected its efficiency, but it would be to a very limited extent.

513. I believe that the Board of Trade is in the habit of applying to the Trinity House to procure tenders for the illuminating apparatus for lighthouses in the colonies?—Yes, they have done so.

514. Do you remember what assistance the Board of Trade asked of the Trinity House in the matter of the Great Basses Lighthouse?—I have no recollection of any correspondence on the subject.

515. (*Mr. Gladstone.*) Has the Trinity House ever exercised the power given it over local lights, buoys, and beacons, by the Merchant Shipping Act, Section 394?—A case occurred recently, in which a Local Authority wished to discontinue a Light on the ground that they had not funds for maintaining it, but the Trinity House would not sanction its being discontinued.

516. In the visits of the Commissioners they have found that some of the local lights are in a very bad and inefficient condition; have you ever enforced any improvement of such a light?—No, we have not considered the mode of maintenance of Local Lights to be under our jurisdiction.

517. Then, however faulty a Local Light may be, do you imagine that you have no control over it whatever?—As we have no control whatever over local funds, we do not deem it proper to control their expenditure. We consider Local Lights to be regulated by the local authorities from their own funds.

518. (*Chairman.*) But setting aside the question of your authority, you will probably be of opinion that it is scarcely to be called a local question, where, as in the case of Aberystwith in the month of November of last year, several vessels were wrecked, and a considerable loss of life occasioned from the deficiency and bad management of the local light, when it is very possible that some of those vessels might have been foreigners, and that neither the property nor the lives lost could be said to be of local interest?—The result was undoubtedly general in its importance, and so far not a question of local interest.

519. (*Mr. Gladstone.*) Have you any special means of ascertaining the condition of lights, buoys, and beacons under the management of local authorities?—We do not interfere with local authorities unless we are applied to by them.

520. Then however bad a local light may be, you do not officially become acquainted with the fact?—No, not officially.

521. (*Chairman.*) Then supposing that a light under the management of either of the two other general authorities were commonly complained of as defective, is there any machinery by which you would necessarily become officially acquainted with such fact any more than in a case of a local light?—I think a defect in any General Light, I mean under either of the different boards, would very soon be represented to us, but I consider those Lights in a very different position from Local Lights.

522. But would that be the case under any present statutory enactment or rule of office?—Any defect of a Coast Light under either of the other authorities would be represented by them to us with any proposition for its improvement.

523. Has any case ever occurred in which a light under either of the Scotch or Irish Boards has been so complained of or represented to the Trinity House?—Cases have been submitted to us by the other Boards for the improvement of coast lights, which have been concurred in, I think, invariably.

524. Then has any complaint ever been made to you from those who are interested in the lights—that is, those who use them—of a faulty light, and a light faulty from bad management, &c., belonging either to the Scotch or Irish Board?—I have no recollection of a single complaint of Lights belonging to either of the Boards.

525. By Clause 392 of the Merchant Shipping Act, the Trinity Board has power at all times to enter any of the Scotch or Irish Lighthouses; has that power in any case been exercised?—Very frequently.

526. Has the exercise of that power been in consequence of any representation as to deficiency, or any remarks of your own as to deficiency or imperfection?—No, but as taking the opportunity of being in the locality to visit and compare different Lights, and they are visited whenever an opportunity occurs.

527. You say that these lights are visited whenever opportunities occur; does the reply to Question 8, Circular 1, at Page 79, and those which follow include all the inspections of those lights which took place in those two years?—Yes, they do, but we do not consider that we are called upon to visit the Scotch and Irish Lights unless there may be some special reason for doing so.

528. (*Mr. Gladstone.*) Has a local lighthouse, buoy, or beacon ever been surrendered to the Trinity House under the authority given in the Merchant Shipping Act by Section 413?—No; but cases have arisen in which application has been made to the Trinity House to take Local Lights under their management as at Dartmouth and Carnarvon.

529. Has this been carried out in either of those cases?—No; because there did not appear to be funds sufficient for their maintenance.

530. Am I right in believing that the Trinity House gave certain buoys to the town of Dartmouth?—Yes, they did.

531. Are you aware whether they have maintained those buoys?—They are maintained, but we have represented that they were not maintained in a proper condition.

532. Supposing you hear, as we have heard with respect to Dartmouth, that a buoy is off its station, do you consider that you have no power to compel the local authorities to replace it?—Only by representation. We should represent to the authority that such an accident had taken place, and call their attention to it in order that it might be replaced.

533. But supposing that request were disregarded, what step would then be taken?—I consider that our authority would cease then, unless by application to Her Majesty in Council for the transference to us, which would involve the imposition of an adequate toll for maintenance.

534. (*Chairman.*) I believe that Mr. James Walker is the engineer employed by the Trinity House for lighthouse purposes. Has he any particular title, such as lighthouse engineer, or any other?—He is termed Engineer in Chief to the Trinity House.

535. Could you give the Commissioners an outline of the duties that Mr. Walker has to perform?—To make preliminary surveys and reports where any works such as Lighthouses and dwellings, or Beacons or storehouses are proposed—to prepare preliminary designs and approximate estimates of cost—to report on alterations that may be proposed—to prepare detailed and working drawings, with specifications, conditions, &c., with copy for contractors—to superintend the execution of the work—to report the progress of each work weekly, or as required—to grant certificates—and finally to adjust accounts and differences where the works are under contract—to make purchases and contracts for materials—to engage workmen—arrange wages, and examine and certify bills. In some cases, as the Needles and the Snails, where the tenders from contractors have exceeded the Engineer's estimates, the Elder Brethren have committed the work to Mr. Walker, to make contracts for the materials, and to have the works executed by workmen, paid by the Corporation. In these cases the total cost has been

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less than the lowest tender received. I may add that Mr. Walker has to find his own clerks and office assistants, and that the labour which devolves upon them must be very considerable.

536. Then these duties, which you have just detailed as belonging to Mr. Walker, relate specially and exclusively to works connected with building?—Yes, but I should have added that Mr. Walker has also lately been consulted on some matters, such as lanterns for foreign stations, the Electro-Magnetic light, purchases of land, armature of apparatus, revolving machinery, &c.; he also prepares plans and specifications for Lighting Apparatus.

537. He has nothing to do then with the examination of lighthouse apparatus?—Not the illuminating apparatus.

538. It would appear that in Scotland there is an officer entitled superintendent of light keepers, whose duty it is to go round to the several lighthouses in Scotland, and to examine the lightkeepers as to their entire proficiency in all their duties, and who has to report periodically to the Commissioners of Northern Lighthouses. There is also in the Scotch establishment a "foreman of light-room repairs," who in like manner periodically visits all the lighthouses, to see that the apparatus, machinery, &c. are in perfect order, in order that he may perform any necessary repairs on the spot. Has the Trinity House any such officer?—No; this duty is performed under the frequent supervision of Committees of the Elder Brethren. An establishment was formed at Blackwall, for the purpose of effecting repairs to lamps, &c., but was found to be more expensive and less efficient than when performed by the lamp manufacturer employed by the Corporation.

539. Then am I to understand that the lamp manufacturer pays any periodical visits such as are performed by the superintendent of lightkeepers and the foreman of lightroom repairs in Scotland?—No, he acts only under orders received from the Board.

540. I believe that the per-centage formerly allowed to collectors of customs for calculating vessels' expenses for light duties has been abolished; can you say when that allowance was withdrawn?—No per-centage has been allowed by the Board of Trade where an appointment or transfer to another port has taken place subsequently to the 29th of April, 1854, excepting to the ports of Cowes, Deal, Falmouth, Milford, and Weymouth, where a commission is still allowed in consideration of the collection being made partially afloat.

541. Are you aware of any complaints having been made as to difficulties in obtaining the accustomed calculations since the allowance was abolished?—There have been remonstrances from various collectors as to the hardship of having to do this work without remuneration, and of being held responsible for errors when they have no benefit of commission, nor in some cases, the aid of a clerk, and perform more laborious duties than their predecessors did.

542. It must occasionally occur that demands are made upon you for assistance in cases of urgent personal distress or disaster, have you any fund set apart and included in the estimate submitted to the Board of Trade, to enable you to meet such cases on the moment?—To meet those cases, 100*l.* per annum has, upon the representation of the Elder Brethren, been sanctioned in the annual estimates, to be applied at our discretion (without previously representing the circumstances to the Board of Trade) in payment of any allowances for medical and other expenses caused by the illness of lightkeepers, seamen, &c.; but it is to be confined to cases where the need for medical attendance is caused by circumstances specially connected with the service.

543. I believe in the consideration you have had to give to the question of establishing an Electric Light, the risk to be incurred by erecting the necessary machinery within the lighthouse itself has been an important one?—Yes, it has.

544. Has that been from any apprehension as to the explosion of the boiler?—The Lighthouse not

being adequate for the space required for the machinery is one cause, and, secondly, from the unwillingness to incur any risk from accident that might happen to the boiler or machinery within the building.

545. Can you state what is the horse power that Mr. Holmes reckons to be necessary for working the machinery?—I think it is two engines of three horse power.

546. I suppose it would be scarcely possible to burst the boiler of an engine of three horse power?—I am not prepared to answer that question.

547. In the selection of Dungeness as the site for the approaching exhibition of that light, I suppose that the additional expense that would be incurred for carriage was fully taken into consideration?—Yes, all this was fully considered. Circumstances, however, have arisen which render it possible that the selection of that site may not be carried into effect.

548. I would ask you, supposing all things equal, and that the Electric Light were equally applicable to a revolving as to a fixed Light, whether such a site as the Start, which is one of the salient points of our coast, and an important and favourite landfall, would be by you considered as a more eligible position for the exhibition of the light than Dungeness?—As a position there can be no doubt that it would be superior, but the difficulty, that has hitherto arisen is, that with our present knowledge of the electric light some doubt exists as to whether it is so well adapted for a revolving as for a fixed light; but this will probably be tested.

549. (*Mr. Gladstone.*) As a general principle, would you adopt the dioptric system for the illumination of a new lighthouse?—As a general principle, I should say yes, but it would depend very much upon the arc to be illuminated.

550. Would it depend at all upon whether it was a fixed or a revolving light?—A fixed coast Light would be dioptric, but I am by no means satisfied that for a revolving light the dioptric is the best.

551. You have, I know, lately substituted the catoptric for the catoptric apparatus in one or two lighthouses; has the Board of Trade made any objection to the expense?—None, beyond their vigilance as to our contracts.

552. Were the reflectors worn out?—They have been defective. Wherever we have found it necessary to incur considerable expense for repairs we have established the dioptric system.

553. (*Chairman.*) What is the class of men generally selected by the Elder Brethren to form part of the crew of a lightship?—Young men who have been at sea.

554. Are any particular qualifications or certificates required of them?—Certificates of age and health, and of conduct and character as seamen in the ships in which they have served.

555. It is immaterial, I conclude, whether they have served in men-of-war or in merchantmen?—Quite so; we have many from both the navy and merchant service.

556. Have you any fixed limit with regard to the age of those who are entered for the Lightship service?—No man is admitted above the age of 28.

557. Do you superannuate them at any particular age?—No, there is no specified age; but if a man is found to be unable to perform his duties, he is superannuated.

558. You have said that they are not admitted after the age of 28. Take the case of a seaman from a man-of-war who would become entitled to his retiring pension, and say a full retiring pension, which in these days he may arrive at between the ages of 35 and 40, and supposing him, in addition to his good character, to be a healthy man, you would still think that the rule had better be adhered to, which on the one hand would keep such a man out of the service, and on the other obliges you to enter a comparatively young man?—Yes, I consider it should be adhered to, because it would not be just to pension a man from the Mercantile Marine Fund who had

not passed the prime of his life in a service paid from that fund.

559. Are there any regulations in force which provide for each man composing the crew of a lightship being instructed in the art of trimming lamps, cleaning reflectors, &c.?—No, not the crew generally.

560. Then by what process is a selection made of those men who have the charge of the lamps and

lamp room?—Men are selected, according to their seniority, who are desirous of becoming lamp trimmers in the Lightvessels, and they are instructed in the necessary duties.

561. Do these men receive a higher salary than the rest of the crew?—Yes, a slight increase; and the senior seaman on board a Lightvessel applies, if he wishes, for that appointment.

Adjourned.

Wednesday, 2nd January 1861.

PRESENT :

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON, R.N.
JOHN HALL GLADSTONE, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

WILLIAM HENRY CUTLER, Esq., and Professor FREDERICK HALE HOLMES, examined.

565. (*Chairman to Mr. Cutler.*) I believe you are employed professionally by the proprietors of the Electric Light?—Yes.

566. Then you can inform the Commissioners probably how matters stand financially respecting the light?—A very large outlay has been incurred by the proprietors with a view to the development of the light, and this outlay is constantly being increased, and no return has been received by the proprietors, except a few hundred pounds from the Trinity House for the use of the apparatus at the South Foreland, during some experiments that were made at that lighthouse.

567. Is this constant increase that you have mentioned consequent upon any delay that you can attribute to any of the authorities, or is it one that would naturally follow in the course of the proper development of the electric light?—Considering the very long time during which this matter has occupied the attention of the Trinity House, I am inclined to think that a very considerable delay, over and above what would have taken place had I been dealing with ordinary customers, has occurred, and I consider that it is not a delay consequent upon the proper development of the electric light.

568. Can you give the Commissioners any general statement as to the amount that has been expended in the bringing out of this electric light by the present proprietors?—I believe a sum of not less than from 23,000*l.* to 25,000*l.*

569. Can you state at about what date any communications on the subject of the electric light with the Trinity House first commenced?—I believe it was in the year 1856.

570. Can you state what is now doing by the Trinity House with the electric light?—The plans and specifications have, at the request of the Trinity House, been submitted to Mr. Walker, their engineer, with a view to the erection of the apparatus, and the exhibition of the light at Dungeness lighthouse.

571. Do you know whether any orders have been given to the proprietors for proceeding to set up the light at Dungeness lighthouse?—Several months ago, after the experiments at the South Foreland had ceased, and which experiments were considered perfectly satisfactory, we were requested to send to the Trinity House estimates and specifications for erecting the light at Dungeness; we subsequently submitted drawings, specifications, and estimates of the terms, and, so far as I know, they were agreed to. Those plans, specifications, and estimates were subsequently submitted to Mr. Walker, the engineer of the Trinity House, and he required various alterations and additions to be made, principally I believe owing to the peculiarity of the Dungeness lighthouse, which is very ill adapted for the reception of our apparatus on its top, in consequence of an accident by lightning which took place some years ago. These altera-

tions and additions of Mr. Walker rendered it necessary for us to alter our estimate and specification, and considerably increase the sum for which we originally offered to adapt the lighthouse to our light. The fresh estimate has not yet been agreed to by the Trinity House.

572. You have stated that the Dungeness Light-house was ill adapted for the electric light in consequence of the condition of the tower, which had been damaged by lightning: setting aside the condition of the tower, do you know whether Dungeness is a site that the proprietors of the light would have considered a desirable one, in all respects, for the exhibition of the electric light?—Certainly not; Dungeness would not have been the lighthouse selected by the proprietors, inasmuch as its range is only 10 miles and a fifth; nor can it be called a leading light, as other lights are visible at the same time; nor is it on a salient point; nor can that part be considered a useful landfall. The proprietors would have rather chosen an important lighthouse, such as the Start, which is a projecting point of the Channel, where the light can be seen for about 19 miles.

573. You have mentioned the Start as a desirable point for the exhibition of the electric light; you are probably aware that, at the Start, the light is a revolving light, and it has been stated to the Commission that the electric light is not, as yet, adapted for a revolving light?—Mr. Holmes will be better able to give the Commissioners information upon that subject.

574. (*To Professor Holmes.*) How would you describe yourself as connected with the electric light?—That I am the discoverer of the fact that the magneto-electric machine can produce the so-called electric light; that is, a current of electricity passing between separated carbon points.

575. It has been stated to this Commission that the magneto-electric light is not adapted for a revolving light, and that that constitutes an objection to its being exhibited at the Start Lighthouse. Do you differ from that statement which has been made to the Commission?—Certainly; and for this simple reason, if a flashing Fresnel lens is employed, that, as it is admitted that the magneto-electric light can be placed in a focus of an ordinary stationary lens, there can be no possible reason given why there is not also the same focus for it in a flashing lens.

576. Mr. Campbell wishes you to be asked whether, when you put a light in the chief focus of a lens either fixed or revolving, you would provide any means of causing a divergence in the beam greater than that which would result from the size of the light, which is taken to be about the eighth of an inch?—Any amount of desired divergence can be given to a light in constructing the lens; but Messrs. Chance have given me their opinion to the effect that without any

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provision for divergence there will be ample from the light itself, if the lens is properly constructed, and adapted for it.

577. (*To Mr. Cutler.*) You are probably aware of the expense which would have to be incurred in order to adapt the tower of Dungeness, in its present state, for the reception of the electric light. Do you think that if you had been permitted to erect your own tower and apparatus on that site it would have been much more expensive than altering the present tower to receive it?—The additional cost, over and above that to be incurred for adapting the Dungeness Lighthouse to the electric light, would not exceed 2,000*l.* to erect a new iron lighthouse with all the necessary appurtenances, such as light keepers dwellings; whilst the estimated cost of altering the present tower to receive the light would amount to nearly 1,500*l.*

578. In erecting an iron lighthouse tower de novo would you make provision for the machinery necessary for producing the electric light being placed within the tower, and not in buildings adjoining, as is now proposed to be done by the Trinity House?—Certainly.

579. What is the space in square feet that you would require for the engine room?—We should propose to erect the steam engines and apparatus at the upper part of the tower. The advantage of this would be to diminish the number of attendants by one half, and economy in other respects would be the result.

580. You have said that there would be fewer attendants required; how many attendants are now necessary in consequence of the position, by the Trinity House arrangement, of the engine house; and how many would you employ when the engines were placed as you would place them?—Under the Trinity House arrangement two lightkeepers, one engineer, and one assistant, are necessary. By the proposed plan, one engineer and an assistant would be sufficient to do the whole work.

581. Would you work one engine, or would you have duplicate engines?—Probably, for extra-caution sake, two engines may be desirable.

582. I conclude then that with two engines you would work at a very low pressure?—Certainly.

583. Then there could be no danger, humanly speaking, of an engine of three-horse power bursting; and I conclude that there would be less hazard to the lighthouse than now exists in every house where there is a kitchen boiler?—I consider there would be no danger whatever.

584. You consider then that there has been delay in bringing forward and in properly testing this light?—Yes; very considerable delay.

585. Do you consider that delay owing to the matter not being properly understood by the lighthouse authorities?—Most undoubtedly; the subject being one of a very novel and scientific character, it was unlikely that it would be thoroughly understood at first, by the authorities at the Trinity House. I should add that they have, from time to time, as I am aware, consulted Professor Faraday upon the subject, and I believe he has reported very favourably of the light.

586. Are you in a position to state that any continued delay in the erection of the light might be fatal to its exhibition, or at any rate that it would put it beyond the power of the present proprietors to go on with it?—The continual outlay which delay occasions is very considerable; and I fear, if some return is not shortly received by the proprietors, the success of the undertaking will be imperilled.

587. Considering that it would be more or less discreditable to this country, after all that has been done, with its great resources, scientific and otherwise, if the electric light should be exhibited in any foreign country before it is set up in England; can you inform the Commissioners whether there is any project for exhibiting it in any country abroad?—The Brazilian Government have made inquiries on the sub-

ject of the light, and I am informed that they would immediately adopt it in one or two new lighthouses which they are now erecting in that country if it were adopted in this country, and I believe we should also have orders for making the apparatus for the Swedish Government as soon as it was adopted here.

588. (*Mr. Gladstone to Professor Holmes.*) You have stated that you were the discoverer of the fact that the magneto-electric current could be sent between charcoal points, and give a brilliant electric light; can you state to the Commissioners the date of your first experiments?—In 1853 or 1854; I think it was in 1854 in Paris.

589. What led you to make those experiments in Paris?—In 1853 I was asked to be referee in a case in Paris, concerning some magneto-electric machines that were erected for the purpose of producing gas for combustion by the decomposition of water; The proprietor of those machines undertaking that they should produce a certain quantity of gas per hour, and getting up a company there for carrying it out, on the experiment being tried it was found to be a failure. The machines then for a time were considered useless, and several persons, M. Becquerel, others, and myself, were requested to give an opinion as to the purpose or purposes for which these machines might be made available; all, but myself, decided that they were no more than toys; but I proposed that they might be employed, and that I would (by certain alterations that I would undertake to make in the machines), enable them to be used for the deposition of metals in electroplating and gilding; perhaps, in some instances, for the decomposition of mineral substances. But above this I gave my opinion that I thought it possible to produce the electric light by means of those machines. My propositions were entirely ridiculed, and the consequence was that instead of saying that I thought I could do it, I promised to do it by a certain day. On that day, with one of Duboseq's regulators or lamps, I produced the magneto-electric light for the first time. But as the machines were ill constructed for the purpose, and as I had considerable difficulty to make even a temporary adjustment, to produce a fitting current, the light could only be exhibited for a few minutes at a time, say 10 or 20 minutes, when the adjustments were entirely displaced by the friction; the rubbing surfaces were worn away. From this time I directed my attention more particularly to the reconstruction of the machines entirely, from the very framework upwards, so as to produce the current that I saw necessary for the electric light. In order to get rid of the friction I employed rollers, at first small, which became, from the large amount of electricity passing, melted with the heat, and I now employ large ones, exposing a broad surface of contact, so that after 16 or 17 hours continual work the whole of the machine, in every part of it, remains perfectly cool, showing that there is no injurious friction in any part of it.

590. The French Government have lately been performing experiments with the magneto-electric light; do you consider that these experiments grew out of your first trials?—The experiments now being tried in France are being carried on by a man who was formerly instructed by me, and working under me; they were being carried on by the identical machine which I left in Paris.

591. Did you continue your experiments long in Paris?—A short time after the first production of the light, I left Paris in consequence of not liking the treatment I received from the French Company, and I then went to Belgium, as a machine had been constructed there under my directions, and with that machine I continued my experiments. About this time, in 1856, Captain, now Admiral, Fitzroy, was commissioned by the Admiralty to go to Brussels and see the light, and report upon it. And at that time the light obtained was, within a mere fraction, as powerful as I have it at the present time. Shortly after his return to London, I

came over and saw Captain Shephard, of the Trinity House, and got his permission to put a magneto-electric machine up at their Experimental Lighthouse at Blackwall, and it was there tried for a number of nights, say from 6 till 10 in the evening; and, from the satisfaction that it seemed to give to the Trinity House authorities, the South Foreland Lighthouse was given to me to place the light in; my understanding with the Trinity House at that time being, that if, at the end of three months, there was no fault found with the light, then it should be placed permanently in some lighthouse. At the end of the three months trial at the South Foreland the Trinity House required a further trial of six months, during which six months it was to be entirely under their own control, I not being allowed to interfere at all in the carrying out of the experiment. During this time the light was put to a very severe test, as one of the lightkeepers, who had been accustomed to the arrangement, of the lamps in the lantern from the commencement was suddenly removed, and another took his place without any previous instruction. This man, being unacquainted with the light, thought it was quite strong enough if he allowed the carbon points to touch, as then the light required no attendance whatever, and he could leave it in that way for hours together; and I had to report to the Trinity House that such was the case, and that whenever this man was on duty there was a very poor light, and that his answer, when spoken to by the other lightkeeper, had been, "It is quite good enough." One of the lightkeepers from the lower light at the South Foreland was ordered to instruct him, and this man, the instructor, had never had an hour's management of the lamp, except during the interval of a few days between the leaving of the first lightkeeper and the coming of his successor; still, with that slight amount of instruction, the man was able afterwards to carry out those instructions so as to keep the light at its proper brightness the whole of the night without difficulty. This took place with lamps or regulators, which I have now superseded. The difficulty of managing those lamps was not in their construction, but in consequence of their being composed of clockwork: and, what with changes of temperature, the hardening of the oil in this clockwork, and the rough manner in which uneducated men poured the oil into this clockwork, the lamps were liable to stoppage, and then, if not attended to, the light would become extinct. In the new lamps to supersede those, all the clockwork is omitted, and I now feel perfectly independent of a man for three hours at a time. The attendance of the lightkeeper will be simply required to renew the carbons every three or four hours; and in case of one carbon burning a little faster than the other, so as to cause the point to ascend or descend, that he should then, by merely turning a little button, regulate the height from time to time.

592. (*Chairman.*) Has the lightkeeper any means of ascertaining when the point is descending or ascending above or below the focus, without actually looking at the flame itself?—At the back of the light is a small reflector, a few inches in diameter, occupying a part of the lantern that is black or dark; through this reflector a small hole is drilled, and the light passing through this hole falls on a disc, on which are three lines. When the light is perfectly in focus, this small star or disc of light falls across the centre line; if it ascends, it falls on the lower line; if it descends, it falls on the upper one, or approaches it. Therefore, without looking at the light, the man simply regards the position of this luminous point on the disc, and turns the button accordingly, either up or down.

593. (*Mr. Gladstone.*) Your present apparatus includes an elaborate contrivance for bringing the alternate positive and negative currents into one direction: did this form part of your original apparatus?—Yes. My original idea was that it would be necessary to have the current always in one direction

in order to keep up a constant stream of vaporized carbon from one point to the other. Now, I do not consider that absolutely necessary, as I find that the current passing alternately from each carbon point to the other will produce still the electric light, in consequence of the enormous rapidity of the changes of direction; while the vapour produced by the current before it is still between the carbon points in sufficient quantity to carry the electricity. The light produced by this means is not of the same character as the other. In this both carbons burn at the same rate. The focus is larger, in consequence of both ends or extremities of the carbon being equally heated; but there is always, and must necessarily be, a coloured flame surrounding the light, giving it a very peculiar character, and distinguishing it completely from the magneto-electric light, produced by the current passing always in one direction. This is owing, I believe, to the dispersion of particles of carbon into the air by the contact of the two, the upward and downward stream of vaporized or liquefied carbon, the particles so projected into the surrounding air burning and producing the peculiar flame of carbonic oxide.

594. Do you propose to use the alternate currents, or the currents brought into one direction, at Dungeness?—The currents uniformly in one direction.

595. Do you think that that has a preponderance of advantage?—I believe the advantage to be this, that the light is more steady, and quite free from that peculiar tremulousness that to me is exceedingly disagreeable to the eye when close to it; whether it is injurious to the eye permanently I am not prepared to say.

596. Are the carbons employed by you the same as those employed in producing the ordinary galvanoelectric light?—Any carbons that will suit the one electricity will suit the other.

597. Have you made many experiments on carbons?—No, I have not; I have taken those that are to be got in the market up to the present time.

598. (*Chairman.*) Are you aware of the exact description of carbon now being used in making the experiments at Paris?—Yes. One kind of prepared carbon now employed in Paris, if it can be manufactured, would give a very superior light: but hitherto, from all I can learn, no pieces have been made of it more than three inches long, from some difficulty, I believe, in its manufacture. Of the carbons that I employ each pair consists of one a foot long, and the other six inches long. I believe also that another manufacturer is taking up the subject now in Paris; and although not manufacturing carbons so perfectly as the small specimens that I saw there, still they are much more free from iron than any that I have hitherto had to use.

599. What is the length of the carbon that you consider necessary to be placed in the machinery of a lighthouse?—A lamp consumes five inches an hour, or from five to five and a half, the two together. Hence, if the sum of the two together is about 18 inches, the light will continue for upwards of three hours without changing the lamp.

600. (*Mr. Gladstone.*) Have you made any experiments with a view to obtain a variety in the colour of the light, by steeping the carbons in different salts, or any such methods?—I have; and the result, as far as a coloured light is concerned, is satisfactory; but as far as the lens is concerned, it is most unsatisfactory, as a deposition of the vapour of whatever I impregnate the carbon with is deposited in all directions on the glass of the lanterns and on the lens, rendering it opaque in a few hours, and in many instances to produce a coloured light; and as very poisonous substances are used it must necessarily be injurious to the health of the keepers, who have to breathe a contaminated atmosphere. I may mention as one, nitrate of strontia, which produces a reddish coloured light, and is highly poisonous.

601. Do you not think it possible that you may discover some substance, the products of the decom-

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position of which are permanent gases at the ordinary temperature, and not injurious?—I am not at present aware of any such; but as regards the exhibition of colour, three or more short chimneys, built one on to the other, each of them an inch or so in length, placed at the end of a lever, clockwork giving motion to them upwards and downwards, will cause changes in the colour of the light from white through two or three or more colours, to white, and back again, with any required velocity.

602. (*Chairman.*) What do you consider will be the size and diameter of the lenticular apparatus required for the exhibition of your light for light-house purposes, and for a fixed light?—The size lens that I should employ would be that of the sixth order, the focus being so small, merely requiring such a size lens as to enable the hand to be put within to clean it.

603. Have you made any calculation as to the difference of cost between such an apparatus and that required for a first class dioptric light?—The best answer perhaps that I can give to that question will be the estimate that Mr. Chance gives me for lantern, and the lens complete for the electric light as intended to be mounted at Dungeness, and that amounts, I believe, to 445*l*. But this includes two entire lenticular apparatus, mounted one over the other, in order that, on the carbons in one lamp being entirely consumed, the lamp, now ready in the other lenticular apparatus, is simply ignited, and in doing this the one in which the carbon has been consumed is extinguished at the same instant, and thus, by means of the two lenses, the light never ceases for an instant.

604. Then whilst the cost of the dioptric apparatus at the North Foreland is 1,018*l*. 10*s*., including transport for one light, you are to be charged 445*l*. for two illuminating apparatus?—Precisely so. I would also add that the lantern is constructed of bent plate glass with diagonal bars, made very thin, so that no shadow can possibly be thrown on any part of the sea.

605. (*Mr. Gladstone.*) How long do you imagine that a set of magnets will last in constant use in your machine?—If in constant use, for ever; the effect of the helices passing the magnets being to continue the strength of the magnets up to a certain point. I find by experience that the magnets are stronger after six months' use than they were after a week's use. On taking the machine to pieces at the South Foreland, by direct trials made of their strength, the comparisons being made with the strength taken at the time of erection, I find that the strength is identical with that after the first removal of the armatures, immediately after their being magnetized; they cannot wear out, as they are not touched in any part by the revolving armatures. I am glad to have this opportunity of contradicting a report circulated by an engineer who has been employed by the Board of Trade, that the machines were taken to pieces at the South Foreland, and the magnets found to have lost all their force. The value of such an assertion may be known from this, that at the time the report was spread the machines were not taken apart.

606. Is there much wear and tear in any other part of the apparatus?—No more than the ordinary wear and tear of double conical bearings, with which I believe the amount of friction to be reduced to its minimum. The commutator merely, from the slight action on its edges of the current of electricity, requires trimming, or in other words, dressing on the surface, every six weeks. The commutator will wear out in about 30 years, and the cost of renewal would be about 20*l*.

607. (*Chairman.*) Do you consider that the magneto-electric light can be said to have had a complete and fair trial at the South Foreland, considering that the lenticular apparatus there was adapted for a Fresnel oil lamp of three inches and three quarters in diameter?—If the lens had been perfect for that

diameter of lamp or light, it could not have been fit for a light the eighth of an inch in diameter. Hence it would follow that a full lens of light could not be seen from any point; but in fact, at the commencement of the experiments at the South Foreland, the lens was most imperfect for the Fresnel lamp itself.

608. You have said that the lens at the South Foreland Light was most imperfect for the Fresnel lamp itself; did you find that the zones or prisms were less imperfect than the lenses?—The imperfection was principally in the zones or prisms; one panel of the lens only was out of the perpendicular, throwing the light upwards; but with regard to the zones, to the best of my remembrance, out of 96 zones only two directed the rays of light horizontally, the other 94, with one or two exceptions, throwing the light upwards at a considerable angle, instead of on to the sea or to the horizon; some of them as much as one inch in a foot, and one of them more than an inch and a half in one foot.

609. This dis-adjustment that you speak of is with reference to the lamp as originally fitted?—Yes.

610. How was it ascertained that this one lens and the 94 zones or prisms were so much out of adjustment?—When a person is in the lantern of any lighthouse, and looks across the lens, so as to allow the eye to look towards the glass on the opposite side of the lantern between the prisms, then, if the light passes from those prisms in a perfectly horizontal line, it would be impossible to see the reflected light upon the glass of the lantern. But observing in this manner the South Foreland lens, I found, to my surprise, that the light thrown back to my eye from the glass of the lantern was that of a prism two ranks, in some instances, lower than the one I was looking over. And with respect to the defective adjustment in any panel of the lens, this may be readily discovered by placing the eye on the level of the centre of the flame, and then observing the reflected light on the lens itself. If the reflected light from the lens itself is thrown back to the eye exactly across the line of light you are looking at, then the panel is perpendicular and in its place, but if not, it shows at any rate that one surface of the lens is out of the perpendicular; and in examining the lens I have alluded to in this way, I found the reflected ray to be thrown much below the centre of the light, and therefore sending its light upwards, above the sea. The direction of this panel was towards the Dungeness Lighthouse; it passed over Dover Harbour.

611. Did you take any steps for the re-adjustment of the defective lens, or of the 94 defective zones or prisms?—The first defect that I reported to the Trinity House was, that the shadows of the brass framing of the lens did not fall on the astragals of the lantern, but fell at the side of them, so increasing the shadow materially at sea. Upon this one of the Elder Brethren came down to see the lens, and ordered the lens to be turned slightly on its axis. This did not remedy the defect, and for this reason—the lens is an inch and a half or thereabout out of the centre of the lantern, and therefore in putting one shadow right, the others were made worse. I took that opportunity of one of the Elder Brethren being down there a second time, to mention the defect in the prisms, and on calling at the Trinity House some time after, I saw Professor Faraday there, and we had some conversation on the subject. It was then proposed that Mr. Wilkins should send down a man to alter any prisms that I should point out as being defective, and to change their position in the frames; but it was then proposed at the same time that the correction should be made by sloping the entire panel containing a set of these defective prisms, but that I was on no account to adjust it for my light, but it was to be adjusted for a large Fresnel lamp. On the man coming down to make these alterations he soon discovered that it was totally impossible to make the correction by any alteration in the position of the panel; that each zone or prism would require to be removed and re-set,

and this he at once commenced doing, employing as his assistants the two lightkeepers. On commencing to re-set them after one day's work I observed the effect at night, and found that they were still very much out of the truth, some of them being very much over corrected so as to direct the rays too much in a downward direction; and the next day I assisted the man by showing him a ready means of ascertaining when the rays passed exactly in a horizontal direction from the lens. This was done by placing on the outside of the lens a straight edge—say three feet in length—on which a spirit level being placed, it was nicely adjusted to a level, the end of the edge being exactly opposite the middle of any zone to be adjusted; the red ball of an inch and a half in diameter, previously used as representing the flame of the lamp, being in its place. On directing the eye along this straight edge to the prism, the ball ought to be seen; and now the defect was very readily discovered in the set of these zones or prisms, for it was found, in many instances, that the eye had to be elevated three inches, still looking to the centre of this prism, before this ball could be seen. And on changing the prism slowly, and altering its set, these rays, passing through the prism from the ball, were gradually brought down, so that at last the eye, on looking in a direct line corresponding with the straight edge, saw the centre of the ball exactly opposite to that. In this way not only the lower but the upper prisms were altered; and to the best of my remembrance there were only two that were found correct enough to leave them as they were. The time occupied in doing this I believe to have been between two and three weeks.

612. In the last reply you spoke of adjusting the lenses and prisms horizontally; do you mean to the geometric or to the sea horizon?—To the geometric horizon, as that was the direction that was given, Wilkins's man having orders to correct them to the exact level, or exactly at right angles to the perpendicular.

613. Mr. Campbell wishes you to be asked whether the electric light and the red ball, of which you have spoken, were set in the focus of the lens in the axis of the whole instrument, and generally as much in the centre as possible?—In adjusting the lens and prisms the red ball was placed in the exact centre, but my light was always placed by me at about 3-16ths of an inch above the true centre, but still in the axis of the apparatus.

614. (*Mr. Gladstone.*) Were the 3-16ths of an inch with a view to bringing the horizontal beam of light down to the sea horizon?—It was.

615. (*Chairman.*) Mr. Campbell wishes you to be asked whether, in raising your light so as to bring the beam of light down to the sea horizon, you considered the case of the prisms as well as the case of the lenses?—Yes. I knew that I should lose a portion of light from the upper prisms, but as I considered my light or luminous point to be beyond the focus of the apparatus, in consequence of being in the axis instead of round the axis, as the flame of the lamp is, the raising of this point compensated in some measure for its distance further back, and brought the rays of the lower prisms further out towards the horizon than they would otherwise have fallen.

616. Mr. Campbell understands you to say, that when the operation was completed the upper prisms were sending rays above the geometric horizon; the lens part was sending rays down to the sea horizon, and the lower prisms were sending rays to the geometric horizon?—It is true that the lens was sending the rays to the sea horizon, the lower prisms were also sending them to the sea horizon, because I do not consider that in raising the light 3-16ths of an inch, that I raised it sufficiently high to throw them to the geometric horizon. With regard to the upper prisms I sacrificed some rays, but the rays of my light that fall on the upper prisms are only the rays of the lower carbons, and not near so powerful as the rays that fall on the lens and lower prisms.

617. The electric light being so placed, and about

the size of a pea, how do you account for the fact that it was seen close to Dover, and on the horizon?—In this way, that although my light was raised 3-16ths of an inch above the true centre of the lenticular apparatus, still it was by my calculation 1-8th and a sixteenth below where it should have been placed to bring the rays from the lower prisms to the geometric horizon.

618. Will you look at this drawing (*in the Appendix to the Report.*) (*The same being shown to the witness.*) This is traced from the inverted image of the landscape formed by the lens at the South Foreland lighthouse, on a sheet of ground glass placed in the focus of the lens; your light was accordingly in this position; by what process did you get the divergence which is represented on this drawing by nearly three inches of flame, whereas your light is represented by 1-8th of an inch, and corresponds in size with the image of a ship distant about a mile?—With regard to the distant rays it was in fact simply the divergence due to the formation of the lens, but the light falling on the sea close in shore was due to the reflection by the small circular conical reflector placed under the light horizontally to intercept all those rays that fell on the service table of the lens, and in fact all that fell below the lower series of zones or prisms. Those rays so reflected were thrown up into the third and fourth rank of the upper prisms, coming then, as it were, from a point something like three inches or more below the real focus of the lens; they made a corresponding angle in issuing from the upper prisms with the horizontal line, and hence descended to the sea at a distance varying from two to four miles.

619. In the apparatus which is now being constructed by Mr. Chance for the magneto-electric light to be exhibited at Dungeness, is provision made by reflectors, or by any other means, for obtaining the requisite divergence; I mean sufficient to illuminate the sea in shore?—This part does not concern the apparatus at all that Mr. Chance is making, but depends entirely upon a small reflector that will be placed in the same position, and below the luminous point. But the effect in the small lens will be much greater; instead of throwing the light so far out at sea, as at the South Foreland, the light will now be brought almost close round the lighthouse.

620. Mr. Campbell wishes you to be asked with reference to the rays that went further to sea. It was observed by the Commissioners, on their visit to the lighthouse at the South Foreland, that, besides the conical reflector which you have mentioned, there was another reflector placed behind the electric light, which appeared to be an upright reflector, composed of two portions of a hollow cylinder. Will that reflector, in any way, account for the divergence which was discovered to exist, and which has not yet been accounted for?—I should say decidedly not. The use of that reflector was partially to destroy the enormous shadows produced conjointly by the frame of the lens and the astragals of the lantern, and was so formed that, looking at that, and the light from any point round the lantern, the light reflected in the reflector was always distant from the light itself three inches, and thus that light always passed into and crossed the shadow from the main light. But that the light reflected from this was not at all equal to the light itself was very evident to any one standing outside the lighthouse, as then, in the air, the shadow from the astragal and frame still had the appearance of a dark line in the air, and if the light had been equal to that from the reflector these lines or shadows in the air would have been nearly invisible.

621. But, in speaking of the first reflector, which you mentioned, you said that in consequence of the reflection the light appeared to radiate from a point behind that reflector; did the light not radiate in like manner, or appear to radiate, from points behind the cylindrical upright reflector also; and did the light not then thereby seem to diverge from the conjugate focus of the lens, so that the lens would bring those rays to a focus at some point outside the lighthouse,

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from which they would again diverge, so as to give the required divergence?—Yes.

622. Will not that perhaps account for the otherwise unexplained divergence?—For the reason I have already given, I should say not, because those rays were so feeble that they could not be called the rays of the light.

623. Were those reflectors of polished silver similar to the reflectors used in the catoptric lighthouses?—Yes, they were.

624. Then why should the rays from that piece of silver be less brilliant than the reflected rays from other pieces of silver?—Because the form of the reflector prevented the formation of a focus, whereas in large reflectors intended to be used in lighthouses the construction is such that the rays from the focus pass out nearly in parallel lines, and you see, from wherever it can be observed, the whole reflected on the same field; but in my small reflector the reverse was the case, the light in that always appearing less in size from its peculiar curvature than the light itself.

625. Had you these reflectors from the beginning, and was the light always placed as you have described?—The light was always placed slightly above the true centre of the lens, but I had not the reflectors at the commencement.

626. Was the divergence observed to be the same after the reflectors were there as before?—The first report that was made to me on the divergence of the light, was by Professor Faraday, who said that he was surprised to find the sea so lighted up, and so equally from the horizon to within a few miles of the lighthouse. At that time no reflectors whatever were used, and the application of the reflectors was an afterthought, in consequence of the dark shadows; the total darkness at sea in the shadows of the astragals was misunderstood by captains and others at sea, and was supposed to be a total extinction of the light during the time they sailed or steamed through them, and in consequence of that I placed a small reflector with a peculiar curve at the back of the light.

627. But the other reflector was there before?—No. Then it struck me also, that the light in the lantern was so disagreeably strong that, if I placed a small reflector under the light as well, I might utilise that light by throwing it into the upper prisms, and causing it to light up the sea close in shore.

628. Do you consider that, even after the adjustment of the lens and prisms by Mr. Wilkins's man, the apparatus at the South Foreland was sufficiently adapted for the magneto-electric light to afford a fair trial of that light during the remainder of the experiments?—I do not, the divergence being enormously too great.

629. It appears then, from all you have stated, that a very large proportion of the light which was produced from the magneto-electric light was, with the South Foreland apparatus, and even after the adjustments, thrown upwards above the horizon, and that still the remainder of the light produced that effect beyond and at the horizon, and near the light at Bonlogne, and near Dover, which has been so much admired by those who have observed and reported on the light during its exhibition?—Yes; even with this apparatus, adapted to an enormous lamp compared with my light, I got this effect.

630. It might be stated by some that they were not satisfied as to the sufficiency and accuracy of your means of testing the amount of the divergence, which, you have said, was enormously too great—in fact, double that which you required; what answer would you give to any such objection?—In the first place the light was constantly observed from the lantern of Grisevez, Calais, Dungeness, and the North Foreland. Grisevez, Calais, and the North Foreland, were considerably above my natural horizon; hence if the light was seen there, all the light seen there must have been light perfectly useless at sea. Dungeness is not so much above my horizon as the others, but, being above, I requested that the observations should be made from the foot of the tower, and not

from the lantern; but I found that they were made from the lantern, which, as I have stated, is above my horizon. I have also tried the amount of divergence, by allowing the shadow from an opaque substance to be thrown through the rays at night, and I have always found that nearly half the rays pass above the horizon. In these observations I have used the Gull Stream Light as my horizon at night, and I have also frequently observed the under surfaces of clouds, passing over the sea at perhaps two or three miles distance, illuminated; although, from the fact that the Calais Light was perfectly visible under the clouds, I should judge that their altitude must have been considerably above that of the lighthouse.

631. (Mr. Gladstone.) You spoke of the upper prisms being of minor importance, because the main light was from the upper charcoal point?—Yes.

632. The upper prisms form a more complete series usually than the lower prisms, and I presume that there would be no difficulty in inverting the position of those points?—Not the least. In lenses constructed for the electric light, the lower prisms would be increased, and the upper prisms would be diminished, as being less useful.

633. (Chairman.) You mean in constructing them?—Yes. An inverted lens, such as that of the South Foreland, would certainly have been more effective for me than in its present state.

634. (Mr. Gladstone.) Can you not adjust the light so as to throw a considerable amount of rays upon the upper prisms?—Yes; by a different construction of the lamp or regulator I can cause the current to pass in a reverse direction; hence the lower carbon would become the more luminous, and the upper carbon the less luminous in opposite positions to the present. In that case the powerful rays would all be thrown upon the upper prisms.

635. Supposing you allowed alternate negative and positive currents to pass between the charcoals, would you not have both points equally luminous?—Certainly.

636. Do you think that anything would be gained by that?—I do not; at present my opinion is the contrary, that neither of them would become so luminous as by the present method of sending the current in one direction. I have at present no reason to alter that opinion.

637. The electric light from charcoal points contains a very large amount of highly refrangible rays. I observed at the South Foreland that the glass became, in consequence, fluorescent; do you think that this self-luminous glass adds, to an appreciable extent, to the value of the light?—To a certain extent I would say yes. The light given off by this lens in a state of fluorescence is very perceptible, where the direct rays cannot be seen at all; and I have found that it, together with the diffused light of the lantern, gives a shadow equal to that made by the moon when four days old at a distance from the lighthouse of about 300 yards.

638. (Chairman.) Mr. Campbell wishes you to be asked whether, amongst your methods of testing the divergence of a beam, you ever tried to ascertain whether you could see the light from the lower South Foreland lantern before those reflectors of which you have spoken were placed there?—The direct rays of light, before the reflectors were placed, were not visible from the lantern of the South Foreland, that is the lower South Foreland.*

639. (Mr. Gladstone.) Were they afterwards?—Yes; and always from the prism on which the lower reflector threw the light.

640. (Chairman.) Mr. Campbell wishes you to be asked this question, whether after the reflectors were placed, on looking from the lower South Foreland the light was visible in any part of the apparatus in the upper lighthouse at the South Foreland?—It was visible in the upper prisms.

* The image of the lantern of the lower tower was formed by the refractors, in the upper at about three inches above the burner, and two inches above the image of the horizon.—J. F. C.

641. (*Mr. Gladstone.*) Have you ever experienced any difficulty from chromatic aberration; or, in other words, has the whole divergent beam of light been always a uniform colour throughout its divergence?—No beam of light in passing through any one prism escaped decomposition; but the result of the assemblage of these coloured rays after passing (speaking now of the rays direct from the luminous point) gave almost a uniform tint, but not perfectly. Sometimes to the eye the ray would appear slightly reddened, at other times slightly greenish, but in a very slight degree. Not so with regard to the rays taken up by the lower horizontal reflector. From this the rays were highly coloured, and I considered that this might be turned to useful account, in letting the mariner know when he was too close in shore.

642. Has chromatic aberration formed a subject of consideration between you and Mr. Chance in arranging the new apparatus?—He says he can nearly do away with it.

643. (*Chairman.*) Have you received any application to light buoys or beacons by means of the magneto-electric light?—No, I have not; but its applicability for the purpose is extraordinary, and I have no hesitation in saying that I am prepared to place a series of buoys of a peculiar construction, say round a sand bank, that shall require visiting not more than once in three months; that those buoys shall alternately for a short period, say half a minute, shine with the electric light in its full force one after the other, so that no instant shall occur when none of the buoys are luminous, and that this shall continue night after night for three months, without renewing the carbons, or without any attendance whatever except at the machine room on shore. All that would be required for it on shore would be one system of apparatus for producing the electric light similar to the one lately in use at the South Foreland, and two men to attend to it; and then at periods of three months, say, some persons instructed in it, to visit those different buoys, and to renew the carbons. The structure that I propose for the buoys has some peculiarities. Each buoy is provided with what I term a water anchor, as well as the cables and anchors that anchor it to the bottom of the sea. This water anchor consists of a flat plate double the diameter of the buoy, or even more than double the diameter, through a hole in the centre of which the cables pass; this flat iron plate is supported by chains hanging to hooks round the buoy; its depth in the water ought not to be less than ten feet, and the effect of it is that a wave striking the side of the buoy presses with equal force, from its extra weight, upon that side of the flat plate, and prevents nearly all rolling motion in the buoy. The light apparatus applied to each buoy would be on the top of a short mast, so as to raise it, say from 10 to 20 feet above the level of the sea; but no protection would be required either from the weather or from the sea, the light burning equally brilliant, if not more brilliant, under water than in the air. Should the wind be high enough to blow it out, by the very principle of its construction it re-lights itself in an instant, and this may occur over and over again during the half minute of the time that it is to give light, and will merely occasion in a high wind a series of brilliant flashes instead of a constant light.

644. You consider, I presume, that the magneto-electric light would be perfectly applicable for light ships?—It is perfectly applicable for light ships in two different ways; one where a ship is built for it, and takes its machines and stock of coals on board; and the other where the position of the light required is sufficiently near shore to carry out an electric cable to it, and then the apparatus may be placed on shore. I have designed an apparatus to allow for the

rise and fall of the tide without fracturing the cable.

645. Reverting to the question of expense or difference of cost between the magneto electric light and a first-class light on the dioptric principle, or of a light so costly as that at Beechey Head, where there are 30 burners; do you consider that a very material saving would be effected by a more general application of the magneto-electric light to light-houses, &c.?—If the apparatus is placed as I should wish it to be, in the watch room at the top of the tower, that is, immediately under the lantern, so that no more than the present staff, only of a different class, would be required, then the expense of the magneto-electric light, including fuel, the carbon burnt in the lamp, and employing one engineer instead of a lightkeeper, at a higher salary, would not exceed the expense of such a light as that at Beechey Head. But perhaps it is hardly so much a question of economy as of efficiency; for as the light has been increased from an argand burner, of an inch in diameter, to one of three inches and three sixteenths in diameter, burning sixteen times as much oil, and evidently at sixteen times the cost, for the purpose of greater efficiency, in proposing this light with its properly adjusted lens, I imagine it will give five times the light of such a large lamp; and there seems at once to be no reason why five times the price should not be paid for it. But the real cost of such a light, as I have stated before, with all the proper accommodation for the apparatus at the top of the lighthouse, will not in my opinion be greater than that of Beechey Head.

646. (*Mr. Gladstone.*) Have you paid any attention to the use of reflectors instead of the dioptric apparatus?—Yes, I have paid a great deal of attention to reflectors, and I have made several forms of reflectors for the purpose of revolving or flashing lights. These reflectors are of a peculiar form, the lower portion of the reflector, up nearly to the centre, being generated by a parabolic curve, moved horizontally through forty-five degrees, and then revolving on its axis, so as to form the end curves of the reflector; the upper portion being formed in the same manner, but using an elliptical curve, causing it to revolve also horizontally on its axis through forty-five degrees, and then by revolving on its axis producing a curve at the two ends of the reflector, the curvature being brought down about three quarters of an inch below the horizontal line in which the light would be placed. The effect of such a reflector as this, when revolving quickly, is that the light remains visible for one-eighth of the time of its revolution, and in that case appears to be perfectly uniform. When revolving slowly the light still remains for more than the eighth part of the time of its revolution, but it appears brightest at coming on and going off, owing to the concentrated rays from the two ends of the reflector passing the eye successively. The upper portion of the reflector has the effect of lighting up all the sea equally from the point that it first strikes it—and that point may be chosen at will—to the horizon. The effect, also, of continuing the elliptical curve at the two ends of the reflector below the light is to partly destroy that inequality in the light which is produced from the parabolic part, as it sends the rays through the other focus of the ellipse, and then spreads them out, fan-like, horizontally. Suppose for instance, that the parabolic rays diverged four or five degrees, making in all forty-nine or fifty degrees, the others may be made to diverge at ten miles distance, so as to cover several miles more of horizon; in fact the divergence is entirely at the will of the constructor of the reflector, depending entirely upon the distance of the outside of the focus of the ellipse, or in fact the distance between the two foci of the ellipse.

W. H. Cutler
Esq.
Prof. F. H.
Holmes.
2 Jan. 1861.

Adjourned.

Wednesday, 23rd January 1861.

PRESENT :

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON, R.N.

Captain ALFRED PHILLIPS RYDER, R.N.

JOHN HALL GLADSTONE, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

Northern Lighthouse Office,

Edinburgh, January 17, 1861.

A. Cunningham, Esq.

D. Stevenson, Esq.

23 Jan 1861.

I AM directed by the Commissioners of Northern Lighthouses to acknowledge receipt of your telegraphic message of 15th, and of Admiral Hamilton's letter of same date, and to state that the Secretary and Mr. Stevenson will be in attendance on Tuesday, the 22nd, at 12 o'clock noon.

They will then arrange as to the Commissioners' attendance, if not accompanied by them.

I am, &c.

The Secretary ALEX. CUNNINGHAM, Secretary.
Royal Commission on Lights, &c.

Royal Commission on Lights, Buoys, and Beacons,
7, Millbank Street, 19th January, 1861.

WITH reference to the last paragraph of your letter of the 17th inst., I am directed to state that the Commissioners are unwilling to give the Northern Lights Commissioners the trouble of coming to London, but if there is any point on which they think this Commission should be specially informed, or if there is any statement connected with the management of Scotch Lighthouses they would wish to make, this Commission would be glad to have the same in writing with as little delay as possible.

I am, &c.

J. F. CAMPBELL,

Secretary.

'A. Cunningham, Esq.

A statement was sent on the 19th of February, and is added to the evidence at p. 186.

Mr. ALEXANDER CUNNINGHAM and Mr. DAVID STEVENSON examined.

647. (*Chairman to Mr. Cunningham.*) You are Secretary to the Commissioners of Northern Lighthouses?—Yes.

648. How long have you been secretary to the Commissioners?—I have been secretary since 1842. I have been in the service since 1826.

649. I believe the number of the Commissioners is 28?—Yes.

650. Under the Act there is power, I believe, to add to the number?—Yes, which has been acted upon; the Provosts of Dundee and Greenock have been assumed.

651. Since what time?—Since the passing of the Act of Victoria, chapter 104, and the sheriff of Haddington was assumed too, at a general meeting in January, now current, in consequence of the erection of a lighthouse at St. Abb's Head.

652. Making the number 29?—No, not adding to the number, because of the death of Mr. Urquhart, the week before, and his vacancy not being filled up, his sheriffship merges in another county.

653. They are called the provosts of royal burghs, and of Greenock?—Yes.

654. They are not necessarily royal burghs?—Not necessarily.

655. (*Capt. Ryder.*) Are all the royal burghs included?—No.

656. (*Chairman.*) Does the Act, constituting the present board of Commissioners of Lighthouses, provide for the summoning and holding of meetings?—Not the present Act, which is the 17th and 18th of Vict., cap. 184. The previous Acts are all repealed, and the Commissioners are re-incorporated under that Act.

657. (*Capt. Ryder.*) There is no provision?—No.

658. (*Chairman.*) By the 18th section of the original Act, provision was made for the meetings of the Commissioners?—Yes, and in point of fact, the Commissioners have now four general meetings in the year, and a committee meeting once a fortnight.

659. It has fallen to you, I believe, to prepare the

returns, which have been sent from time to time to this Commission, in answer to our requisitions?—Yes.

660. From some of those returns, it would appear that very lengthened correspondence between the Commissioners of Northern Lighthouses and the Board of Trade has taken place?—Yes.

661. Has this correspondence arisen out of the powers given to the Board of Trade, under the Merchant Shipping Act of 1854?—Yes.

662. Are you aware, whether the Commissioners of Northern Lighthouses interpret the action of the Board of Trade under that Act, in the same way that the Board of Trade does?—I think not, judging from their actions.

663. In answer to the requisition of this Commission, dated the 4th of June 1859, it is stated that the duties of the Commissioners of Northern Lighthouses are to take charge of those lighthouses; that, prior to 1857, those duties were discharged by a committee of all the members resident in Edinburgh, which committee met every alternate Wednesday, denominated the Bell Rock Committee, but that many of the most efficient members having withdrawn their attendance, on account of dissatisfaction with, and, indeed, the constant interference by, the Board of Trade, which they considered prejudicial to the interests of the commission, an attempt was made to reconstruct the committee, by appointing a committee of three to attend each month by rotation. Those committees were composed, in a great measure, of members, who, although equally dissatisfied with the proceedings of the Board of Trade, yet considered it their duty to continue to act. Can you inform the Commission, whether it was on account of the nature and extent of the control, exercised by the Board of Trade, or of the manner in which it was exercised, or both, that occasioned this very serious cessation of the Commissioners of Northern Lights?—I should say it was from both.

664. Then with respect to the nature and extent of the control exercised by the Board of Trade, are you prepared to state any cases in illustration of the nature and extent of that control?—I think they were generally stated in the correspondence which has been transmitted to the Commission. The first discussion arose in regard to Whalsey Skerry, the next in regard to Flugga or North Unst, as it is called, and then, the lights on the west coast, and generally, regarding estimates of expenditure of all kinds.

665. (*Capt. Ryder.*) Since the passing of the Act?—Yes. Perhaps I might add, that the services of the Commissioners are entirely gratuitous, and my impression is, that they felt this constant interference, and the non-appreciation of their services, and that this feeling induced them to withdraw.

666. (*Chairman.*) As secretary to the Commissioners, and being perfectly conversant, not only with the frequency of their attendance, but with the attention, more or less, which they paid to their duties, are you prepared to say that those gentlemen have devoted the best of their attention to the business they were called upon to transact on all occasions?—Yes.

667. Do you consider that that attention has been in its results, of service to the public, as far as the lighthouses in that country are concerned?—I should say so certainly.

668. You have referred to the returns made to this Commission for cases illustrating the manner in which the control of the Board of Trade has been exercised over the northern Board?—Yes, I have.

669. One of those cases I see is the question of the site of a lighthouse at Whalsey Skerry in Shetland, and the point in dispute was a distance of about 700 yards, and whether the light should be placed upon the extreme point of danger, or at a more commodious point for building at that distance within the danger. The

Board of Trade you say overruled you?—They did eventually.

670. Under what section of the Merchant Shipping Act of 1854 do you consider that the Board of Trade had the power of determining questions of site?—It is under sections 404, 405 and 406; but the control as to Whalley did not take place under this Act; it was built before this Act was passed, at least it was in progress. It was the first Merchant Shipping Act.

671. It would appear from the correspondence that there had been considerable discussion between the Commissioners of Northern Lights and the Trinity House upon the subject of the site of this lighthouse?—Yes.

672. The matter has ended in the light being placed in a position different from that which the Commissioners of Northern Lights recommended?—Yes.

673. I believe that in general the complaint of the Board of Trade has been that the Commissioners of Northern Lights have been an expensive body?—I believe it has, but I do not know. It is so stated in Capt. Sullivan's evidence before the Merchant Shipping Committee.

674. We gather from the correspondence in this case, first, that if the Northern Commissioners had not been overruled the light would have cost about 10,000*l.* less than it has cost, irrespective of the very great additional cost for maintenance on account of its position; and secondly, that if it had been in the position recommended by the Commissioners, it would have shown over a larger area than it does at present?—Yes.

675. Is it the case that Mr. David Stevenson, who is now employed as one of the engineers to the Commissioners of Northern Lighthouses, used to have a seat at the Board?—Yes, he had.

676. Since when has he ceased to sit at the Board?—Since January, 1855. It was one of the first acts of the Board of Trade. In consequence of a representation from the Board of Trade a long correspondence ensued, and the Commissioners remonstrated, and even threatened to resign their position as Commissioners, if he was withdrawn.

677. Then it would appear that they had a very strong opinion as to the value of Mr. Stevenson's services as an officer of their Board?—Yes; they had.

678. As an officer of that Board, did he act as a permanent inspector, or could you specify at all the duties that he was called upon to perform?—He had charge of the ordinary maintenance of the establishment, the preparation of plans, and the inspection of new works. The maintenance of the ordinary establishment was after his resignation transferred to me.

679. But the preparation of plans is still confided to Mr. Stevenson?—Yes; to Messrs. Stevenson.

680. Can you specify more particularly those services which were formerly performed by Mr. Stevenson, as an officer of the Scotch board, and which are now conducted by you in consequence of his ceasing to be an officer of that board?—The ordinary maintenance and superintendence of the existing lights, the formation of contracts for stores, the care and inspection of the light keepers, providing stores of all descriptions, and keeping the light houses and machinery in proper repair.

681. (*Capt. Ryder.*) In fact, the duty of a general manager?—Yes.

682. (*Chairman.*) Then Mr. Stevenson was able to pay periodical visits, and personally to inspect the various lighthouses under the Board?—I think that he annually inspected every lighthouse on the establishment of the Board at that time.

683. I see that, in the return sent to this Commission, there is a superintendent of light keepers, and a foreman of lighthouse repairs?—There are. Those are officers who now act under me.

684. Those officers were in existence while Mr. Stevenson was an officer of the Board?—They were.

685. (*Capt. Ryder.*) What is your title now?—I am called Secretary and sometimes General Manager.

686. There is no addition to the title?—No.

687. (*Mr. Gladstone.*) Are there questions arising at the ordinary meetings of the Board, which involve engineering or scientific knowledge?—Constantly.

688. Do you think it desirable that there should be

some one always present at the meetings who is acquainted with those subjects?—I think it would be very advantageous.

689. Does it not sometimes happen that those questions, although of some importance, are not of sufficient importance to submit formally to Mr. Stevenson?—It does.

690. At present if those questions are submitted to Mr. Stevenson, does that involve the paying him a fee?—It does.

691. (*Captain Ryder.*) What was Mr. Stevenson's salary when he was engineer and manager of the Board?—900*l.* a year, besides the assistant's time in preparing plans for new works, and all travelling expenses.

692. Is that the salary for one assistant?—It is just the charge for making the plans.

693. Can you give a list of the payments to Mr. Stevenson during the five years since his change of position?—The fees paid to Messrs. Stevenson since 1st January 1855 to 1st January 1861, being six years, have amounted, on an average, to 1,252*l.* per annum, which, includes all expenses for travelling charges and assistants' time. During these six years Messrs. Stevenson have designed and executed for the Commissioners 13 new lighthouses, and designed and started four, being, in all, 17 lighthouses, 10 beacons, four alterations of stations, in all 31 new works, which have cost 125,100*l.*, the whole of which has been paid under certificates granted from time to time by the engineers. Besides this about 40 surveys and reports on remits have been made, and several elaborate trains of experiments have been conducted, the whole of which duties have been included under the average payment of 1,252*l.* per annum for engineering charges and expenses. That portion of Mr. Stevenson's duties which he performed as manager was transferred to me, and an addition was made to my salary—it was then 800*l.*—of 100*l.*, making 900*l.*, and about a third of my time is occupied by this new business.

694. (*Chairman.*) Has there been any saving effected in consequence of the change of Mr. Stevenson's position?—I should think there has, considering the number of works, and the impossibility of Mr. Stevenson being able, combined with the ordinary management, to have superintended the erection of the numerous extensive works which have been carried on during the last five years.

695. (*Captain Ryder to Mr. Stevenson.*) Could you at the previous salary have conducted those numerous works, with the duties of management as well?—Certainly not. It would have been quite impossible.

696. (*Mr. Gladstone to Mr. Cunningham.*) If a scientific improvement, engineering or otherwise, be suggested to the Board, what is the course at present adopted for testing its value?—It is remitted to the engineer to experiment upon, and report under the direction of the Board; and he is paid separately. But all such payments are included in the statement I have made as to the payments received by Messrs. Stevenson.

697. (*Captain Ryder.*) Can you give the Commission any idea of the number of experiments so remitted, and the expense that has been incurred in respect of them?—There have been five or six such remits and reports. The sum paid has been 123*l.* 9*s.* and Messrs. Stevenson are at present engaged in further experiments.

698. Are as many scientific improvements now submitted to the Board as when Mr. Stevenson attended its meetings?—Pretty much the same.

699. But some improvements are suggested which are really of little or no value; are all improvements submitted to the engineers, or do the Commissioners use their own discretion?—There are some suggestions which any one can see through. I do not think that those are remitted to the engineers; the more important are remitted.

700. (*Chairman.*) Can you inform this Commission whether there is any prospect of the lighthouse on the Skerville, or Iron Rock, being commenced in the Sound of Jura?—It is impossible for me to say.

701. Can you inform the Commission where that matter is now hung up?—The Commissioners origi-

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nally reported upon the proposed site, and the Board of Trade and the Trinity House concurred with the Commissioners in the selection of Skervuile as the proper site for the erection of the light. The Commissioners then proceeded to give orders to the engineer to prepare the plans, which he did, and the specification and estimates were sent to the Board of Trade. They objected to the amount of the estimate.

702. Did they approve of the plans?—Yes, they did. They wrote to the Commissioners to say that they would give 6,000*l.* to be expended on that light, and the Commissioners had recourse again to their engineers to ask them whether the plans could possibly be executed for 6,000*l.* The engineers reported that it was quite impossible, but that they could put up a lighthouse on Skervuile for 6,000*l.*, of wood, if the Board of Trade approved. The Board of Trade wrote back to say, that they did not object to the plans; but the lighthouse must be built for 6,000*l.* or not at all. The estimate was 9,360*l.*, and the Commissioners wrote back to say that they were very sorry the light was not to be erected. There has been some correspondence since of which I have brought a copy, from which I will read this passage—“It has occurred to my Lords, with a view of settling this long pending question, that the objects in view might possibly be attained by placing a light on Dunans Head abreast of the Iron Rock, with a red band of light thrown over the rock.”

703. In the letter you have just read to the Commission a passage occurs to the effect, that it has occurred to the Lords of the Committee of Privy Council for Trade, with the view of settling this long pending question, that the objects in view might possibly be attained “by placing the light on Dunan Head abreast of the Iron Rock.” Under what section of the Merchant Shipping Act of 1854 do you consider the Board of Trade empowered to suggest sites?—I do not find any section which confers such a power, unless it be assumed under the 40*th* section, where the Board of Trade may “give any directions they may think fit in relation to the matters submitted to them.” But the Commissioners, the Trinity House, and the Board of Trade being agreed, and having expressed their agreement upon the site, I would hold that the powers of the statute are exhausted, and that if any other site is to be adopted, the directions of the statute must be again followed out. If the site agreed upon is to be rejected, and another site to be adopted, the whole of the process must be gone through again, as provided in the statute.

704. But as there is this question of change of site, and as this work has been in abeyance for about three years, what is there to prevent these changes going on *ad infinitum*?—Nothing.

705. I believe that very strong opinions have been expressed to the Commissioners as to the eligibility of the Iron Rock, and the expediency of selecting it as the position for the light?—There have; and they have expressed their opinion to the Board of Trade, that the Iron Rock should have had the precedence in execution of other lights on that coast. I may mention a conversation which I had with Capt. Graham of the “Clansman” at Oban, a vessel which passes up and down the Sound of Jura twice a week, in which he stated that he never could go to rest until he was past the Skervuile Rock, either going or returning; that he never considered himself in safety till he knew he was past that. This conversation he accompanied with a request to know whether the Commissioners would authorize the exhibition of a light upon a distillery on the shore, because he said that the lights from the furnaces of that distillery had occasionally guided him past; and that even that, however small it might be, would be a relief to him. I told him that the exhibition of such a temporary light as he suggested was a matter which the Commissioners could not entertain; that the other proposal was before the Board of Trade, and it rested with them to authorize it. He expressed his opinion that he would like a light on the Iron Rock in preference to all the other lights erecting on the coast, as he considered it much more important,

The Commissioners coincide in those opinions expressed by Capt. Graham; and upon this point I will read an extract from a letter which was addressed to the Board of Trade, dated the 28*th* April 1859:—“With these remarks the Commissioners confidently submit this important question for the consideration of my Lords, reminding their Lordships that the Commissioners have already pointed out that a light in this situation, lying in the highway from the Clyde to the highlands, and frequented by many thousands of human beings, is more urgently wanted than others that are in progress. Thus, it is only a few years since that a steamer of the value of 15,000*l.* was totally wrecked on the rock in question. And the Commissioners think that the trade will have just cause to complain if the erection of the lighthouse is abandoned in consequence of the estimate being higher than may have been contemplated by my Lords, while other lights of much less importance are being proceeded with.”

706. Can you remind the Committee of the date on which Messrs. Stevenson's original estimate for the lighthouse on the Iron Rock was forwarded to the Board of Trade?—March 1859.

707. I believe it is the case that the engineers employed on this occasion have not been able in any way to diminish the original estimate upon the plans which have been approved by the Board of Trade?—They have not.

708. Can you state generally what the usual number of contractors is that tender for the erection of lighthouses in Scotland?—They vary very much—according to the extent of work which induces a great many to come forward.

709. Does it ever include tenders from other parts than from Scotland?—It has never yet, but that is not the fault of the Commissioners. When the plans are returned by the Board of Trade and approved, the Commissioners advertise for contractors in the local papers, and in the “Times” newspaper in London, and, in answer to those advertisements tenders are transmitted. In the recent case of Monach, where this course was pursued, the Commissioners had 15 inquiries, including one from London and one from Londonderry. The following are the addresses:—Mr. Henderson, Glasgow; Mr. McDonald, Glasgow; Messrs. Barr and Co., Ardrossan; Mr. R. Montgomery, Mull; Mr. A. Kinghorn, Leith; Mr. D. W. Arnott, Inverness; Mr. D. Scott, Montrose; Mr. Mackay, Inverness; Mr. Stuart, Peterhead; Mr. Dunnet, Helensburgh; Mr. Robertson, Portree; Mr. Russell, Glasgow; Mr. H. Kinghorn, Londonderry; Mr. Jackson, 10, Cannon Street, London; Mr. Spence, Mull.

710. How many tenders were there?—Of those eight tenders.

711. Were they all Scotch?—Yes. In other cases the Commissioners are prevented from advertising by the Board of Trade for their tenders, such as for lanterns and apparatus, and they are directed to transmit the specifications to certain named houses in England and Scotland. I may also mention the lightning conductors. In 1857, the Commissioners issued tenders to two firms in Scotland, Messrs. Milne and Son, and Adie and Son. Milne and Son's offer of 206*l.* 15*s.* 6*d.* was recommended to the Board of Trade for acceptance; and had the Commissioners been untrammelled, would have been accepted of before a letter came from Messrs. Milne and Son withdrawing their offer in consequence of a rise in the price of copper. The Board of Trade then directed the Commissioners to reissue their tenders, and named in addition four houses in England and two in Glasgow. This was done, and tenders again submitted from one house in London, one in Glasgow, and the previous offerers, Messrs. Adie and Son and Milne and Son. Milne and Son were again the lowest at 256*l.* 10*s.*; but at an advance on their previous offer of 50*l.*, and it was accepted. Thus a loss of 50*l.* on this article was incurred solely from the delay caused by transmitting the tenders to London. Again, in the course of last year, the Commissioners applied to the Board of Trade for their sanction to supply lightning conductors, when the Board of Trade wrote to the Commissioners to suspend operations for a time.

Then came a suggestion that a Mr. Gray of Westminster would supply hollow tube at the rate of 4s. 7½d. per foot, which they stated was much below the rate of the Commissioners previous contract of 6s. 2d½. The Commissioners pointed out that that rate had included fixing and every other cost, while Mr. Gray's was for the rod per foot only, delivered in London. The Board of Trade replied that they had overlooked this, and requested tenders to be issued. Tenders were accordingly sent to all the previous English houses named, with the addition of Gray. Only three Scotch firms tendered. Gray also tendered for the rod,—but not to fit it up—at 3s. 10d. per foot. Adie and Son was accepted; and the contract was made at the rate of 1s. 10½d. per foot for solid rod, or 5s. 3d. inclusive of all expense for fitting.

712. Are you aware that Messrs. Stevenson are sufficiently acquainted with engineering works in England, to be able to answer the questions which this Commission wish shortly to put to Mr. David Stevenson as to the means of comparing the estimates for works similar in name and character in the three countries?—I should think they are, as I believe they have had extensive works to execute, both in England, Ireland, and Scotland.

713. (*To Mr. Stevenson.*) The greater part of the voluminous correspondence between the Board of Trade and the Commissioners of Northern Light-houses, which has come before this Commission, has relation to the questions of estimates and the cost of works. Perhaps you could inform the Commission generally where the difference has arisen, or point out particularly where objections have been made to the cost of the works undertaken by the Commissioners of Northern Lights?—With regard to the engineering differences between the Board of Trade and the Commissioners of Northern Lights, in order that you may understand them, I should wish to say that their position, with reference to the Board of Trade, has changed on several occasions. Sometimes, as has already been stated, the Commissioners have been resisting what they considered undue expenditure, and sometimes the Board of Trade on their part have been objecting to what they considered to be undue expenditure. I do not of course impute any desire to the officers of the Board of Trade to interfere unnecessarily, but I believe they have sometimes acted on imperfect or inaccurate data. In 1853, when I was appointed as Engineer to the Board, on the resignation of Mr. Alan Stevenson, from bad health, the Board were engaged in building the Whalsey Skerries, and after the Northern Lights were put under the Board of Trade, the first time I was in London, was for the purpose of endeavouring to show that a light in that particular locality was necessary, the Board of Trade being of opinion that it was unnecessary to encounter so much expenditure—about 11,000*l.* in putting a light there. That was the original estimate for the light on Gruna. Then, as it has been explained by Mr. Cunningham, *tho.* interview did not terminate in the result anticipated, and the Board of Trade desired the works to be stopped. Again the Board of Trade, some months afterwards, allowed the light as proposed by the Commissioners on Gruna to go on, but the contractor made a claim amounting to nearly 800*l.* for delay, which was paid to him. Then in 1854 when the Trinity House and the Board of Trade visited Shetland, they proposed that the light should be moved from the Island of Gruna to the Bound Skerry Rock lying about 700 yards in front of it, and be erected there at an additional cost of about 10,000*l.*

714. (*Capt. Ryder.*) Making 20,000*l.* altogether?—Yes. But the Commissioners being of opinion that all the purposes of navigation would be served by having a light on Gruna did not see the propriety of placing it on Bound Skerry. However the Trinity House and the Board of Trade considered the outer spot preferable. The Commissioners explained their views very fully at the time, and those views were generally that this light was intended to mark the geographical position of a long group of islands extending 15 miles from the mainland of Shetland, and not to indicate a local danger, and they could not see the object in removing the light so very small a space as 600 or 700 yards seaward of the site

proposed at such an expense, the exposure of the outer site rendering very substantial and costly works necessary, and a constant extra annual cost in keeping up the light. The other difference of opinion was as to Lamba Ness and Muckle Flugga in the north of Shetland. The Commissioners had put up a temporary light there for the Baltic fleet.

715. At both of those places?—No; at Muckle Flugga. But they had, before putting up that temporary light, expressed their opinion that Lamba Ness was a proper place at which to establish a light, and their reason for doing so was that the light on Lamba Ness would complete along with Whalsey Skerries the lighting of the whole of the eastern coast of Shetland, whereas were the light placed on Muckle Flugga it would be cut off by Lamba Ness, and would leave a large portion of intervening coast dark. In this they were overruled, the Trinity House and the Board of Trade agreeing that Muckle Flugga was the favourable point. The light has been erected there at a cost of about 32,000*l.*, the estimate for the light on Lamba Ness, where the Scotch Board wished the light to be, was 11,000*l.* or 12,000*l.*

716. So that an injury has been done at a cost of 20,000*l.*?—There can be no doubt that such is the difference of cost. The Commissioners were of opinion, after a full investigation of the matter, and they remain so now, that a light on Lamba Ness would have been far more efficient than a light on Muckle Flugga. In fact, my opinion is that to complete the lighting of that coast a light at or near Lamba Ness is still necessary. The Commissioners were memorialized in favour of Lamba Ness by the shipping interest at Peterhead, and thereafter they took the opinion of the different shipping interests on the coast; they applied to Hull, Aberdeen, Dundee, Leith, Frazerburgh, and I believe that all of those different interests concurred in thinking that Lamba Ness was a better site than North Unst. The first question about the estimates, or about the cost of works was with reference to this light at Muckle Flugga. We reported that a permanent light there would cost 27,500*l.*, and Mr. James Walker, the engineer of the Trinity Board, was consulted. The Board of Trade thought that a smaller estimate might be stated, and the plans which we made were subjected to the review of Mr. James Walker, with whom, as there was a question of some little difficulty as to the safety of temporary buildings on that rock, and the best structure for a permanent tower, we very gladly at once agreed to co-operate in the matter. We had a good deal of correspondence with Mr. Walker on the subject, and after inspecting the plans we had prepared Mr. Walker says, "as respects the general design of the tower and the dwellings the principle of economy appears to me to have been very strictly attended to." Those works have been since executed, and the actual cost is 32,478*l.*, it having been estimated by us at 27,500*l.* exclusive of the landing place and stair up to the top of the rock. However, whether the Commissioners in these questions as to the best sites for Whalsey and Unst were right or wrong, they are settled now, and the only reason for referring to them is to show that the Commissioners were actuated by a desire to do as much good as they could for the navigation, and at the same time to do it without expending what they considered to be an unnecessary sum of money. Then the next questions had reference to Ushenish, Rona, Kyleakin, Isle Ornsay, Sound of Mull, and Rhu Vaal. The Commissioners were asked by Admiral Beechey to prepare plans for those on as economical a scale as they could possibly be prepared, and the only difference between the sort of work employed at Muckle Flugga and that adopted at these new lights was that instead of having roofs of lead the Commissioners were asked by the Board of Trade to adopt slate. We reported that in some situations slate might be used, but in others we conceived that it would be not at all a saving ultimately to employ slate, but that lead ought to be adopted. After a good deal of difficulty the Board of Trade agreed to adopt lead for Ushenish, but for the other lights slate was adopted.

717. Can you state the difference in price between

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a slate and a lead roof?—240*l.* including the cost of iron beams instead of wood.

718. On each site?—Yes, there being 240*l.* difference on each site. Those plans, after being all arranged, were sent to the Board of Trade, and, on returning them, a statement was made, that “the designs were made out with due regard to economy.”

719. Be good enough to supply the date when that statement was made?—6th March 1855. Those lights were executed, and, with reference to one of them, Rhu Vaal, it is right to say that the original site which the Commissioners proposed was nearer to the entrance of the Sound of Mull.

720. Which entrance?—The north entrance; but Admiral Beechey, wishing to open up the Sound between Islay and Oronsay, suggested that the site of the light should be moved further out, and that the height of the tower should be raised for that purpose. That increased the original estimate by, I think, a sum of 1,500*l.* Those lights were all arranged and executed, and, after that, I had no reason to suppose that the Commissioners would have had any further difficulty on the subject of the estimates with Admiral Beechey, as they had come to a sort of understanding as to the style of the building and the character of the work, and all the details of it. However, in the meantime, Captain Sullivan was appointed the successor of Admiral Beechey, and then the question came to be considered with regard to Phladda, Corran, and Macarthur's Head; but, with reference to those in particular, the plans that we made out for those lighthouses were, as regards materials and workmanship, the very same as the plans which had been executed under the sanction of the Board of Trade. There was no difference in their style or size, and those on being sent to London were objected to by the Board of Trade on account of their expense. It was suggested that all the cut stone should be taken out of them, for there was cut stone round the windows and round the doors. It was also stated that all the cornices that were in the rooms round the ceilings should be dispensed with. The removal of the cut stone made a difference in the estimate of about 170*l.*

721. On each site?—Yes, and the cornices of about 11*l.*, making together about 180*l.* on each site. After a great deal of correspondence the lights of Macarthur's Head, Phladda, and Corran were approved, and, with this alteration they were executed. Subsequently to that, the Iron Rock and Stour Head, and Butt of Lewis, were also ordered, and the plans for those were submitted to the Board of Trade; and, with reference in particular to the Iron Rock, as has been already explained, that work has been stopped on account of the estimates being higher than their lordships were disposed to sanction. I may explain that those plans which were submitted are exactly the same in character and style in every respect as Macarthur's Head, Corran, and Phladda; and the estimates, in fact, are made out exactly on the same principles as the estimates for those other works which had been executed within the last two or three years.

722. Have you removed what they call the ornamental work from the estimates for Skervuile?—Yes; everything. And I cannot conceive how Captain Sullivan could say that these houses to which I refer were more like gentlemen's houses than lightkeeper's dwellings, as he did in his evidence before the Merchant Shipping Committee. He must, in my opinion, have made some mistake. The houses are simple brick cottages of the plainest kind, with slated roofs, without any cut stone at doors or windows, while the interior is simply plastered, without cornices or any kind of ornament, and the woodwork is plain and simply varnished, and there is no paintwork employed. The Commissioners were asked by the Board of Trade to restrict the estimate of Skervuile to 6,000*l.*; and here, I think, it will be probably right to say that my brother and I have done all that we could to meet the views of the Board as to the matter of keeping down the estimates; but after doing all that we could we saw that the thing in the case of Skervuile was simply impossible, and represented it to the Commissioners, and as a proof of the impossibility of it we referred to the neighbouring work

of Macarthur's Head, which had been sanctioned by the Board of Trade only a year before, which has a tower, only 30 feet high, and houses only for two keepers, the whole of it on the mainland, the sanctioned estimate for which was 5,700*l.*; whereas this work, which the Commissioners were told was not to exceed 6,000*l.*, consisted of dwellings ashore for three lightkeepers, and a detached tower, with lightkeepers' accommodation also, on a rock three miles from the land. We naturally thought that there could be no difficulty in seeing at once that such a thing could not be done, and so we reported; but we said that the only way of meeting the views of the Board of Trade was to make on the rock a timber erection; and after making sketches and considering the thing, we found that we could make such a timber erection for a sum not exceeding 6,000*l.*, including the houses ashore, and we so reported to the Commissioners. However, the Board of Trade in reply objected to the use of timber, and stated that they had no objections whatever to the plans, but they objected to the estimate, and that unless the estimate could be restricted to 6,000*l.* the work must be abandoned. They also referred to houses in Ireland, which they said had been built at a much less cost than those estimated for at Skervuile. A correspondence was accordingly opened with Ireland, and it was found, from the data which we obtained, that the Irish houses, as measured, taking the area of the house accommodation, were actually higher than the estimates which we had given for those to be erected at Skervuile, our estimate being 18*s.* 3*d.*, and the Irish houses 18*s.* 9*d.* per square foot. I understand that the cost per foot for the North Foreland dwellings was 2*s.* 4*d.*; so that if my information is correct, the Scotch prices instead of being the highest are the lowest of the three.

723. Do you mean per square foot?—Yes. So that in that respect it would appear that the Board of Trade had really gone upon imperfect or inaccurate data. We adhered to our opinion, that the works could not be executed under the estimate that we had given; and here I should like just to say, that really an estimate is of no value at all, in fixing the ultimate cost of a work, although it ought to indicate to those undertaking the work the total cost of the undertaking; what I mean is, that an engineer's estimate cannot regulate what the cost of the work is to be. That is purely a contractor's question, and depends upon the view which the contractors take of the site, and the capabilities of the locality. It is the contractor's business to consider that. In taking such offers from contractors, the Board of Northern Lights pursue the very same course which is followed in all the public Boards with which I am connected, and which is also followed by all the public companies with which I have been connected as engineer, and that plan is, that after the plans are made, and the estimates prepared, these estimates do not go into the hands of the contractors; the contractors do not see them, but they are put in possession of the plans and the specifications, and then each contractor for himself makes his own estimate of what the value of the work is. Sometimes the contractor's offer is exceedingly erroneous; for example, the very last tenders that we had for the masonry, &c., of a light-house at Monach, ranged from 7,048*l.* to 17,000*l.*, our estimate being about 8,000*l.*

724. (Capt. Ryder.) Is it possible that any information can reach the contractors, as to the estimate that has been made?—No. I do not see that it is; nor if it were, could it in the least degree influence the tenders for works of masonry in difficult localities, seeing that it is open to competition, and that contractors are numerous. But at all events, there is no cure for it, and it is done with every work in the kingdom. The problem, which, in point of fact, the Board of Trade have asked the Commissioners to solve, as to the Iron Rock, is neither more nor less than to alter the physical circumstances of the locality, seeing that they object to timber, for nothing else will alter the amount of the estimate. I wish further to state, with reference particularly to Captain Sullivan's evidence before the Merchant Shipping Committee of last year, and in support of what I have already said, with reference to the views of the

Board of Trade regarding estimates, that he there draws a comparison between a lighthouse at Harwich, proposed to be erected by the Trinity House, and the proposed lighthouse on Holborn Head. "He states the estimates of the Harwich lighthouse and buildings at 800*l.*, and the apparatus at 400*l.*, being together 1,200*l.*, and that at Holborn Head, which he styles a similar lighthouse, at from 4,000*l.* to 5,000*l.*, and he adduces this in proof of the greater expense of the establishments, erected by the Commissioners of Northern Lighthouses. But it so happens that the two cases are not susceptible of comparison at all. On writing to the Trinity House, the Northern Light Commissioners were informed, that the estimate for the lighthouse at Harwich was 1,000*l.* instead of 800*l.*, as stated by Captain Sullivan, and that the light was a small fixed light, the apparatus illuminating 168 degrees of the horizon, the apparatus being already in their possession, and, therefore, not included in the estimate.

725. Is there a tower?—No; at Harwich it is a light exhibited from a window in the dwelling house. The estimate for Holborn Head submitted by the Commissioners is 4,213*l.*, and this is for dwellings for two light keepers; for a raised tower 10 or 12 feet above the dwelling from which to exhibit the light, this being necessary because the arc of illumination is 225 degrees; a road of communication to the lighthouse which is estimated at 550*l.*; the land at 200*l.*; the revolving apparatus and machinery for a flashing light, and also 10 per cent. for incidents to cover inspector's wages and other contingencies. The only items, therefore, which can be compared are the cost of the dwellings, those in the case of Harwich being, as I have stated, 1600*l.*, and those in the case of Holborn Head being 1250*l.* The increase of 250*l.* is due mainly to the additional cost consequent on a tower being necessary in order to illuminate the larger arc. That appears to be the only item that can be compared in the two cases, and they are estimated seemingly very nearly upon the same terms, instead of being so widely different as has been represented. In proof of the correctness of the estimate which we made for Holborn Head, I have further to state that when the work was advertised for tender there were eight offers; the lowest offer for the work, including dwellings, road walls, &c., was 2,104*l.*, being 48*l.* below our estimate.

726. Can you submit a list of the estimates for the different works executed by the Commissioners of Northern Lights, and of the sums for which they have been completed?

	Estimate of Messrs. Stevenson.	Actual Cost of Work.
Rona lighthouse	5,500	4,960
Kyleakin lighthouse	5,500	6,103
Isle Oronsay lighthouse	4,500	4,462
Ushenib lighthouse	11,500	9,176
Sound of Mull lighthouse	5,000	6,292
Sound of Islay lighthouse	6,500	7,437
Kantickhead lighthouse	5,200	5,661
Bressa Sound lighthouse	5,000	5,163
Wbalsey Skerries lighthouse	29,813	21,450
Unst lighthouse	27,500*	32,478†
Stroma Skerries beacon	1,000	1,191
Vasa beacon	300	139
Loch Inver beacon	700	710
Pabba beacon	500	502
Calliach Stone beacon	80	115
Tuesdale beacon	400	343
Dracur Rock beacon	160	119
Start Point lighthouse, repairs	500	773
Mull of Kintyre lighthouse, repairs	1,924	2,422
Sanna lighthouse, repairs	450	431
Douglas Head, alterations	500	530
Total	103,532	110,374

* Exclusive of landing place and stair.

† Inclusive of landing place and stair.

This list embraces ten lighthouses, seven beacons, four alterations and repairs at stations, being 22

works, on which about 60 different contractors were employed. They were estimated at 103,532*l.*, and have cost 110,374*l.*, being a difference of 6,562*l.*, which may be accounted for by additional work in landing place and stair at North Unst, not included in original estimate, for that work in our original estimate was stated in our report of 9th April 1855, to be only a "general idea of its probable cost" in consequence of its difficulty. The whole has been finished without any legal question with any of the contractors. There are seven lighthouses at present in progress, which have been estimated as follows, but he accounts not being closed their cost cannot, as yet, be stated, viz.:—

Corran	£ 4,240
Phladda	4,760
McArthur's Head	5,730
Holborn Head	4,215
Butt of Lewis	8,600
St. Abb's Head	8,600
Monach Isles	14,400
Sound of Harris Beacons	1,300
Estimated but not sanctioned.	£
Stour Head, lighthouse and road, 3 miles	9,700
Iron Rock lighthouse	9,603

727. Do you think it possible in this case of tendering for a large engineering work, that there could be any agreement between the persons tendering as to the price to be offered, which might secure to them, in rotation, the execution of expensive works?—I do not think that that is possible in this instance, and I may state further, in corroboration of this, that all the works referred to in the table have been let for sums, which my own experience tells me are just about the sums they ought to have been let for. I know, for example, one of our works, Devaar, which was done before we had anything to do with the Board of Trade at all; in that case the contractor shewed me his books, and I was satisfied that he had lost 300*l.* by that contract. He asked me to bring it before the Commissioners to see whether anything could be done, and I did bring it before them, but nothing could be done. The contractor for the Butt of Lewis, now in progress, offered, verbally, 1000*l.* if the Commissioners would rid him of his contract; and this offer was verbally communicated to Captain Sullivan.

728. Are contractors, who the Commissioners may suppose to have lost by their contracts, ever remunerated for the loss?—Never within my own knowledge I think with one exception. I may also add that the plan of remunerating contractors, who have under estimated their work, is certainly not a good one, as it only holds out an inducement for contractors not to go into their offers with sufficient care, in the hope that, if they have made a mistake, they will not suffer by it. In other words, it is not a fair competition; there should be a *bona fide* understanding between the employer and the contractor that his offer is the sum for which he is to do the work. With reference to the acceptance of a tender, the Commissioners have also had considerable difficulty with the Board of Trade. In issuing advertisements, the Commissioners invariably say that they are not bound to accept the lowest tender, the object of this is quite intelligible, it being to prevent people from tendering who have no intention of finishing the work, or who from want of experience have misunderstood its nature, and it is too commonly the case for such people to do so. However, instead of acting upon that principle, the Board of Trade always, in engineering works, have insisted that the Commissioners shall accept the lowest tender, and this has given rise to much correspondence and difference of opinion. And here I would state that in all my experience as an engineer, I never knew any instance of public companies or other Boards for whom I have acted, rejecting the opinion of their engineer as to the acceptance of the tenders—it being his business—and his responsibility to inquire into the necessary requirements of the different offerers, and also into their experience and stability; in fact, their general reputation as contractors; and to advise accordingly. However, in some cases with the

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Board of Trade this has not been done; for example, to take an instance of a very important and expensive light, we recommended that the second lowest offerer ought to be accepted, for reasons which we specified, as we considered that the lowest offerer had not experience in such works, and had taken so mistaken a view of some parts of it, that we did not feel warranted in recommending him to be entrusted with so important a work. There were some of the items of his tender which at once convinced us that he had not given a sufficient amount of attention to the peculiarities of the work, and all this we stated. The Commissioners recommended the rejection of his offer, but the Board of Trade, directed it to be accepted. The contractor, however, withdrew his tender, and we again recommended, that the next lowest offer should be taken; and, after further correspondence, it was agreed to. Another instance I may mention, where tenders were given, and where we felt quite convinced that the amount of the lowest offer would not suffice to purchase the materials. We represented this to the Commissioners, and recommended the third lowest offerer. Our motive was this: the second and third offerers were very near in price; but the third one being resident in Edinburgh, and the second one at a distance, we thought we should be better able to secure the work being properly done, having it so near our own eye; but the Board of Trade directed that the lowest offerer was to be accepted.

729. What was the difference between the offer you recommended and the lowest?—The third offer which we recommended was 47*l.* 10*s.* above the lowest. That lowest offer was, however, accepted, and in reply the contractor stated that he had made an error in his calculations, and he wished an addition to be made to his estimate, which addition brought him above the third offerer; we again reported that the third offer ought to be accepted, but the Board of Trade directed the second offer to be accepted, and he got the work.

730. Is there any other instance?—Yes; with reference to another work, we recommended that the second lowest offerer should be accepted, and represented that the lowest offerer had evidently committed some error, as his price was too low. The Board of Trade directed that the lowest offerer should be accepted, but he afterwards withdrew his offer, stating that he had made an error in his calculations, and the second lowest was then taken.

731. Is there any difference in the time of lighting and extinguishing in Scotland as compared with England and Ireland?—Yes. The late Mr. Robert Stevenson, after consulting Professor Henderson, the professor of practical astronomy, proposed to alter the time of lighting and extinguishing from "sunset till sunrise" to "the going away of daylight in the evening till the return of daylight in the morning," and that change was introduced after observations had been made at a great many lighthouses on distant objects. A table applicable to the site of each lighthouse is calculated and hung in the light room, stating the times of lighting and extinguishing for every day in the year; and upon a calculation made we find that the annual saving due to that alteration is about 1,600*l.* a year. In order further to show that the Commissioners are desirous to effect economy in every possible way, I may state that, in six condensing lights erected in the Sounds of the Western Islands, an annual saving of 34*l.* has been effected. In this particular apparatus, which was the suggestion of my brother, Mr. Thomas Stevenson, by using a small burner, and condensing the rays in the direction of the greatest distance at which they require to be seen, you have, for a small expenditure of oil, the light due to a larger lamp and apparatus. The saving of 34*l.* is for oil and five per cent. interest on the amount of first cost saved which was about 1,000*l.* for the six lights.

732. (*Chairman.*) Have you ever had occasion to call the attention of the lightkeepers to their not

burning sufficient oil?—Yes. With regard to the dioptric lights there is an instruction to the lightkeepers; we know from experience that when that instruction is acted up to, a certain quantity of oil should be expended; not less than a gallon in five hours; and when we find that it does not come up to that, then the attention of the lightkeeper is called to the fact.

733. Are there any instances of the lightkeepers neglecting to burn sufficient oil?—(*Mr. Cunningham.*) There have not been many instances that it would be worth remarking upon. There are certain of the lightkeepers who we see do not burn the quantity, but it is difficult to find fault with them, for they are apt to think too much about it, and they may therefore waste the oil. Where we find that they are decidedly not burning enough then we call their attention to it. In point of fact within the last six months that has been done, for there have been one or two cases in which the lightkeepers have not kept up a proper flame.

(*Mr. Stevenson.*) I might add, to what Mr. Cunningham has stated, that in each light room there is a diagram showing the height of the flame to be kept up; and when, from the consumption of the oil being low, the Commissioners have reason to suppose that the flame has not been fully kept up to the size they have had occasion to represent this to the lightkeeper. When the mechanical lamp was first introduced, indeed, the Commissioners gave a premium of 1*l.* annually to certain lightkeepers for keeping up a good flame, but the practice is not continued now.

734. Do you believe that the flame is almost universally maintained at its very highest?—Yes; at or very near it, that is my firm belief. It requires skill as well as watching. A lightkeeper's duties cannot be performed without a course of regular training, and the efficiency of the light is due to the manner in which these duties are performed. We find that where the best flame is kept up the fewest glasses are broken, and the fewest wicks used. The same lamp glass has been known to last seven years, and the same wicks five or six nights.

(*Chairman.*) What is the material you employ in the construction of your buildings?—Before the Commissioners of Northern Lighthouses were put under the Board of Trade, they had adopted brick, on account of its being a cheaper material than stone or iron, at certain situations; and they had, for the same reasons, recommended that the recent lighthouses should be built of brick; but the Board of Trade have invariably suggested that the stone of the place might be cheaper, and more advantageously employed than brick. We were of a different opinion, believing that the brick would be the cheaper material of the two. This is consequent upon the great expense of opening quarries, and paying damage to the proprietors, and other expenses contingent upon quarrying operations, as well as the uncertainty of getting suitable materials even after the quarries have been opened, the great object of the contractor being, in all these situations, to do as little work as possible on the spot, so as to save taking men, and maintaining them there, for that is a great part of his expense. On all occasions we have put it in the option of the contractor to employ either brick or stone, and we have never got an offer as far as I recollect, in which the contractor did not undertake to make erections of brick cheaper than of stone, and that brick brought from considerable distances. I have further to state as to brick, that the brick that we employ is not common brick, it is composition brick, prepared for the purpose. The Board of Trade have suggested to use common brick, but the Commissioners have represented that it would be very injudicious to employ common brick, more especially as the extra cost of employing the superior brick is only 60*l.* for each lighthouse and buildings.

735. Are there any communications going on with respect to the lighthouse at Holborn Head?—The

last communication with reference to Holtorn Head had regard to the estimate for the lighting apparatus, iron parapet and lantern, &c. which we estimated at 1,135*l.*, the Board of Trade stated that they had received a lower estimate of a similar light from Mr. Wilkins, and desired the Commissioners to alter their estimate to 600*l.*; on this being represented to us by the Commissioners we at once stated that we could not alter our estimate, for an engineer's estimate is made out on the professional responsibility and reputation of the engineer making it; he cannot make an estimate in any respect different from what he believes to be its true value; and that the true plan by which to test Mr. Wilkins' estimate would be for Mr. Wilkins to give in an offer for the work when about to be contracted for, and then it would be seen at what cost it would be executed. At the same time we added that Mr. Wilkins had made several offers for apparatus to be supplied to the Northern Light Commissioners, but he had not as yet succeeded in being the lowest offerer, and consequently, had done no work for them, and further that the plans and specifications were not ready for the lighting apparatus for Holtorn Head. The Board of Trade then wrote, saying that they wished those plans and specifications to be forwarded to them for further consideration, when they were prepared, and that is how the matter stands.

736. Mr. Wilkins, therefore, had never seen the plans or specifications?—No.

737. What is the character of the light at Rona?—A flashing light, of the natural colour.

738. The red shade then has been removed?—Yes.

739. Was Admiral Beechey acting for the Board of Trade, when the character of that light was decided upon?—Yes; he was their adviser.

740. Did he recommend any change?—We recommended to the Commissioners, and the Commissioners to the Board of Trade, that it should be a flashing light, showing white all round the Sound of Applecross. That was submitted to the Board of Trade, and Admiral Beechey recommended that it should show red down the Sound of Applecross. This was ordered to be done by the Board of Trade, and we prepared the red shades for that purpose, and afterwards, upon a visit by Captain Sullivan, before the light was exhibited he conceived that it was better that it should be white down the Sound of Applecross as we had originally designed it, and accordingly the red shades were ordered to be removed, and kept for some other place where a red light was needed.

741. Then in this case who was the authority who first suggested the change in the colour of the light?—Admiral Beechey was the first who, to my personal knowledge, suggested the change.

742. Under what section of the Merchant Shipping Act of 1854 do you conclude that the Board of Trade proceeded to give directions as to the colour of the light?—That I do not know. I have never studied the Act myself.

743. (*To Mr. Cuningham.*) How does the light appear marked on the Admiralty chart now?—In the chart, published eighteen months ago, it was stated to be red, as originally proposed by Admiral Beechey.

744. Have you represented to the Admiralty that that is a mistake?—Yes; that was immediately represented.

745. Has it been altered?—I cannot say whether the chart has been altered or not.

746. Did they ever answer your letter?—No, they never did.

747. The Commissioners of Northern Lights are in the habit of communicating with the Admiralty upon matters relating to lighthouses?—Yes.

748. Frequently?—Not very frequently.

749. (*Capt. Ryder.*) Upon what kind of questions?—It is more in relation to the changes. We revise the list of lights every year; but it was in the course of going round in the Pharos that it was pointed out

that this light was described as red, and from the first port we touched at I sent off a letter to the Admiralty, as the chart had just then been published I have no doubt that it is now correct.

750. Was the original plan of the Commissioners of Northern Lights with regard to the height of the beacon at Cairnbulg carried out?—(*To Mr. Stevenson.*) It was originally intended to be higher, and estimated at 1,000*l.*, but by the directions of the Board of Trade the beacon was cut down, and cost 720*l.* Diminishing the height reduces the cost very little, for all the expensive work of foundations, &c., remains the same.

751. How many feet was it cut down?—About 15 feet.

752. Did the Harbours of Refuge Commissioners visit the neighbourhood?—Yes, they did.

753. Did they express any opinion as to the height of that beacon?—It was stated in evidence at Fraserburgh that it was considered to be too low; and Captain Washington asked me at Peterhead why the Cairnbulg beacon was not higher, and I told him that it had been reduced by the direction of the Board of Trade.

754. Has there been any light built at Kirkwall?—No; not by the Commissioners.

755. Have they had any project before them for building a light there?—Not at Kirkwall, but in the Sound leading into Kirkwall, on Hellyar Holm.

756. Has that project been adopted, and if not, why?—(*To Mr. Cuningham.*)—It has not been adopted. There was a very strong opinion expressed by the Trade as to two stations; one on Thieves Holm, and the other on Hellyar Holm; and the Commissioners without expressing any very decided opinion, although they stated their general preference for Hellyar Holm, communicated those two stations to the Trinity House in the terms of the statute, to submit the matter to the Board of Trade, and the Trinity House wrote back and inquired about the shipping at Kirkwall. The Commissioners sent them an answer to say that there were 471 vessels, of an aggregate tonnage of 49,331, and then came a reply from the Trinity House, declining to submit the light to the Board of Trade. The Commissioners replied to that letter, stating their opinion that the Trinity House in refusing to submit the plans to the Board of Trade had overlooked their functions, as defined by the Act.

(*Some correspondence was handed in.*)

757. (*Chairman.*) This Commission have notified to the Commissioners of Northern Lights that they would have some questions to put about the difference between the Board of Trade and the Commissioners of Northern Lights in the matter of the Pabba beacon; but as the whole of the correspondence relative to that subject is now before the Commission, as given in the evidence of Mr. Farrer, the secretary to the marine department of the Board of Trade, this Commission will not now trouble you with any questions on the subject?—Very well.

758. In his evidence Mr. Farrer has done full justice to the engineers of the Scottish Board, in being at the pains to state that the cost of the works upon which they had been employed in general has approximated very closely to the estimates. (*To Mr. Stevenson.*)—Have you any observation to make about the Tuisdale beacon?—We surveyed the rock and recommended a cast iron beacon in that situation as being a proper structure, considering the exposure and the nature of the rock. That rock is at the entrance of the Sound at the Calf of Man, and is exposed to very heavy seas, as I know from having in 1835 attended an engineering work going on for a whole season at the place. The Board of Trade stated that they conceived the estimate for this beacon, which was 800*l.*, to be too high, and we reported that we could not see that a beacon of that sort could be reduced in height, so as to make any notable difference in the estimate, and that the only plan was to erect a malleable iron beacon; at the same time we pointed out that in that exposed

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situation, where the beacon would be submerged somewhere about nine feet in a very heavy sea, we conceived that a malleable iron structure, from its vibration, was not so good as a cast-iron one.

759. The malleable iron beacons you make are much weaker than cast-iron?—Yes, much weaker, as they are comparatively light and cheap; and the Board of Trade after much correspondence determined upon putting up a malleable iron beacon; but it is quite an experimental structure, seeing that the malleable iron has not been exposed to such seas, and it may be many years before it is exposed to the maximum waves due to the exposure. In that case, our opinion as engineers, was overruled by the Board of Trade.

760. (Capt. Ryder.) You said just now that because of the exposure to which the beacon would be subject you recommended cast iron in preference to malleable?—Yes.

761. (Chairman to Mr. Cunningham.) In reference to the correspondence with respect to North Unst, already before this Commission, have any steps been adopted to facilitate the communication between the lighthouse and the shore?—No; the matters remain exactly as they were when that correspondence was reported.

762. Do you consider that the men in the lighthouse are secure?—If I did there would be end of the question, but I do not consider myself in the slightest degree responsible for their security.

763. (Capt. Ryder.) Is it of great importance that a signal should be made and seen every day that all is well in the lighthouse?—It is.

764. Do you feel confident that the present arrangement is sufficient, and that the man who is directed to go every day to look for the signal does so?—No; and I have numerous complaints from the lightkeepers on shore of the toil that is endured in making a journey of five miles every day over a very rocky headland without any shelter. But in justice to the lightkeepers, I have no reason to doubt that they do it. On one occasion, during the winter of 1853, one of the lightkeepers was nearly lost in the snow.

765. What was the estimated expense for the footway and sentry-box?—750*l*.

766. What was the estimated expense of the electric communication?—600*l*. The Board of Trade wrote and said that they would permit the placing of an electric communication, provided the Commissioners would dismiss their attending boatman, which the Commissioners declined to accede to, as the boatman's services were required to convey the lightkeepers backwards and forwards. Although the island is 195 feet above high water, and the tower 50 feet more above that, the sea has on several occasions passed in pretty large masses of water across the top of the rock.

767. (Chairman to Mr. Stevenson.) In the statement lately made by you it appears that your estimates for the lighthouse and buildings at North Unst were remitted to the engineer of Trinity House for an opinion. Were any objections made by you to your estimates being referred to a third party?—Not in that particular case. Seeing, as is stated in my evidence, that there was a difference of opinion as to the safety of the temporary buildings to be erected on Flugga, and seeing that there was no experience whatever of the nature of the seas there, we cordially agreed that Mr. Walker should be consulted, and we acted in that as we have done in all our business whenever a question of difficulty has occurred. We invariably readily propose that the opinions of our brother engineers should be taken; and I may mention, that in our business we have had occasion to consult Mr. Walker, Mr. Rendell, Mr. George Rennie, Sir William Cubitt, and Mr. James Leslie, of Edinburgh, and other engineers in that way. But when Admiral Beechey proposed, when these Sound lights were to be erected, that our plans and specification should pass under the review of another engineer, we at once said to him, and said to the President of

the Board of Trade at the time, that we could not agree to any such supervision, and that we supposed that Admiral Beechey was not aware what was the practice of engineers in such matters.

768. I think it was stated to this Commission when they were on the West Coast of Scotland that slates had been tried for keepers' dwellings, and that it was found impossible to keep the roofs in an effective state in very exposed situations where slates were tried, for they were being continually blown off, and slaters had to be sent for from a great distance and at awkward times of the year?—In some sheltered situations I have no hesitation whatever in employing slates—but we have stated over and over again to the Commissioners of Northern Lights that in such places as Rona for example or Cantick Head, where the lights are placed near the brow of a hill, the wind acting on the face passes up and strikes the roof of the house at such an angle that the water is blown under the slates, and in such a situation as that we cannot possibly keep the inside of the roofs dry. In such situations I have no hesitation in saying that I do not think it is judicious or advisable to employ slates because the roofing of the house must within a very short time decay from the constant damp caused by the water passing under the slates. The comfort of the keepers is affected if it goes to a great extent; it has not fortunately gone to a great extent in any of these buildings yet; but they are nevertheless damp and we cannot make them dry.

769. You require, do you not, a heavy coping of stonework to keep lead down?—Yes; the roofs are flat and the lead is kept down by a coping of stone. Where these leaden roofs have been applied, I think, probably for 30 years, we have not had any trouble with them; hardly any repairs have been required, and in situations where, if there had been slates, we should have constantly been obliged to repair, which it would be very difficult and troublesome to do in such situations. At the Butt of Lewis when the Board of Trade desired us to adopt slate they expressed an opinion that it might be repaired. We said that there was no town nearer than Stornoway, some 20 miles off, where any tradesman resided, and that of all places in the world that was just the place to apply lead. The Board of Trade on these recommendations acceded to it, and there is to be a leaden roof at the Butt of Lewis, but at St. Ab's Head, though very exposed, they would not sanction it.

770. In their visits to the various lighthouses in Scotland this Commission have observed that many of the lighthouses and the buildings attached to them are not painted white or whitewashed, as is the case generally in England; can you give any reason for the lighthouse towers and buildings in Scotland being so frequently left of the natural colour of the stone, when there can be no doubt that in those latitudes, and in the ordinary state of our atmosphere a great white patch permanently presented to the eye by a white lighthouse and buildings and walls is of the utmost use to the mariner in sailing along the coast or making the land?—I can give no reason for it; I quite concur that all brick towers at all events should be painted white. With reference to many of the northern light towers I may say that from being built of whitish coloured stone they probably do not so much require it.

(Mr. Cunningham.) The prevalence of snow at the most inclement seasons of the year is one great objection, and they would never be seen at all if white.

771. Would not that be a reason for their being painted black or checkered?—Yes, of course; but we have no complaint of their not being perfectly visible.

772. Are you aware whether there is any intention on the part of the Commissioners of Northern Lights to erect any permanent beacon on the Skairs of Cruden or Ratray Briggs or Scotstownhead?—I think not. The Commissioners have recently submitted to the Board of Trade a proposal which emanates from the Skairs of Cruden.

nated from the Admiralty to cut off the light on Buchan Ness and Kinnaird's Head in such a way as to clear Rattray Briggs, the arrangements for that are now in progress, and if that succeeds probably the whole object may be attained by mooring a buoy at the end of the Briggs, whether it will ride there remains to be seen; they are to darken the coast line of light. Messrs. Stevenson are now constructing screens for that purpose, and it will be carried out in the ensuing season. I am not aware that any application has been submitted for marking the Skairs of Cruden.

773. I suppose it may have been reported to the Commissioners of Northern Lights, or they may be aware that many vessels do go on the Rattray Briggs in the day time?—Yes.

774. Then masking the lights of Kinnaird Head and Buchan Ness is so far good that it will be of service to mariners for navigation by night; but you think you will be able to place a buoy of sufficient size and sufficiently secure to guide mariners in passing along the coast by day?—Yes.

775. (*Captain Ryder.*) What kind of buoy are you going to put there?—We have yet to consider that.

776. (*Chairman.*) Is there any intention to place such a buoy?—Yes; and a beacon has been spoken of; but the scheme has not yet been matured.

777. It has been already stated in evidence, in the case of North Unst, that something like a reproof was conveyed to the Commissioners of Northern Lighthouses from the Board of Trade, on account of their having taken the sense and opinions of the passing trade as to the superior recommendations of the site at Lamba Ness, proposed by the Northern Commissioners, over the site at North Unst, proposed by the Trinity House and Board of Trade. You are aware that in the early statutes giving power to the general lighthouse authorities to erect a light, the very essence of that power was made to consist in representations having been made from those engaged in the passing trade as to the necessity for a light in a particular position; do you suppose that this essential element towards establishing a light has been at all abolished by the Merchant Shipping Act of 1854, under which the Board of Trade has found fault with the Northern Commissioners for the course they took in this instance?—I do not consider that it is abolished; but it has fallen into disuse.

778. (*Captain Ryder.*) Do the Northern Commissioners, before they suggest any lighthouses, seek the opinions of the passing trade?—The opinions of the Commissioners are generally founded upon applications from the passing trade, which render it unnecessary for them to seek those opinions.

779. Opinions as to particular sites?—Yes.

780. Under what circumstances was the opinion of the passing trade solicited, with regard to the position of the lighthouse at North Unst as compared with the proposed site at Lamba Ness?—With regard to a remark made in a letter from the Board of Trade, dated the 1st of March 1855, that the Commissioners canvassed for the opinions of ship-masters on the matter referred to, the following are the circumstances:—The Commissioners did not ask any opinions on the subject until it was brought before them anew by a memorial from the shipping masters of Peterhead, pointing out the peculiar advantage of placing a lighthouse on Lamba Ness, and it was remitted to Mr. Stevenson to report on that memorial; the Commissioners then thought it their duty to ascertain the views entertained on this subject in other sea ports carrying on the chief trade with Greenland and the North of Europe by communicating with Aberdeen, Fraserburgh, Dundee, Leith, and Hull. This course, instead of being unusual, has been frequently adopted by the Commissioners with regard to other proposed lighthouses, and the Commissioners in soliciting the opinion of the passing trade were very careful not to show that there was any difference of opinion between them and the Board of Trade, or what site the Commissioners themselves preferred.

781. Referring to the abstract of the correspondence with regard to the proposed erection of a lighthouse at St. Abb's Head, we have observed that the Board of Trade disapprove of the proposal of the Commissioners of Northern Lights to make a survey for the site of the proposed lighthouse. Will you explain what survey was necessary in the case?—

The first letter which the Commissioners addressed to the Board of Trade was quite general, and the reply stated that the communications should have come through the Trinity House in terms of the statute. The Commissioners answered that they would immediately cause a survey to be made, in order that they might ascertain the precise position of the light to submit to the Trinity House and to bring it before the Board of Trade, and the Board of Trade refused to sanction the Commissioners making such a survey. The consequence of this is, that unless the Commissioners are authorized to survey, in order to ascertain the site they would recommend, it becomes impossible for them to make any recommendations to the Trinity House to be submitted to the Board of Trade, as provided by statute.

782. Since that correspondence are you prepared to say that you have made any more suggestions for sites?—None; since that correspondence the commissioners have made no proposals for new lighthouses, the sites of which had not been surveyed previous to that correspondence, but in regard to that of Hellyar Holm, I may explain that that emanated from memorials from different ports in Orkney, which the Commissioners remitted to their engineer to report upon, and having received that report, they transmitted the substance of it to the elder brethren.

783. What steamers have the northern commissioners now?—The "Pharos."

784. What size is she?—250 horse-power and 500 tons over all.

785. Have they any other steamer?—Yes; another steamer which is not in use, the old "Pharos."

786. She is under repair?—No; she is lying in the docks at Leith.

787. Out of repair?—No; she is kept in repair. She is lying in Leith docks, under directions to be sold.

788. Could her services be usefully applied?—I think they might be, and I have directions at this moment from the Commissioners to report to them in detail upon that subject. I think that by dispensing with an equivalent number of attending boats on the west coast, and substituting the old "Pharos" to do their duty, while there are numerous departments of work that she could do, no extra cost would be incurred.

789. Can you use the old "Pharos" without permission from the Board of Trade?—No; we have solicited that permission, and it has been refused. The employment of the old "Pharos" would be an additional expense of about 1,700*l.* or 1,800*l.* a year, but I believe the saving of boat hire on the west coast would exceed that sum.

790. Do you inspect the lighthouses?—I do.

791. Do you visit each of them once a year?—No; from their number I cannot overtake that now.

792. How often do you visit each lighthouse?—I visit each lighthouse at all events once in every two years.

793. What portion of the year is occupied by you in inspecting lighthouses?—July and August, and sometimes September.

794. Do you go alone, or do you go with the Commissioners?—Sometimes with the Commissioners and sometimes alone.

795. Do you think that such an amount of inspection as is made is sufficient?—With a competent staff under me the amount of inspection might be sufficient, but the lighthouses are increasing so rapidly that I think it would require a second inspector of Light Room repairs. The present man cannot possibly overtake the whole of the lighthouses in one year; he cannot get at them in winter, and during the summer

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season he has not time to overtake them and to execute the necessary repairs at all the establishments, so that we are obliged to make a selection of lighthouses for him to visit every year.

796. What were your qualifications for inspecting lighthouses?—None originally; I was educated as a writer to the Signet, and in that capacity was secretary of the Commissioners, but I had no education which qualified me for discharging the engineering duties of the department. My long service, however, and frequent visits have enabled me to pick up a good deal of information as to my duties.

797. What option was given you as to accepting these duties?—None; if any option had been given me I would never have accepted them at the salary at which they were imposed upon me.

798. Do the duties of Secretary and inspector interfere with one another?—Yes, to a certain extent they do; as during my absence my more legitimate duties as secretary are in a great measure at a stand until my return.

799. (Mr. Gladstone.) What are the various duties of the Foreman of Lighthouse Repairs?—He goes round the various establishments with an assistant and executes repairs upon the burners of the lamps, and different things in the light rooms, and that occupies his time, as I have already stated, constantly; he makes a regular tour.

800. Does he make any inspections?—He as well as the Superintendent have instructions to report anything that they see out of order immediately to me; he does not make any authorized inspection.

801. Have you adopted a uniform system of buoyage in all the channels under your jurisdiction?—Yes, we have.

802. (Captain Ryder.) Has that met with general approval?—Very general approval.

803. Have you had any objections made to it?—None; except by the Trinity Board.

804. (Mr. Gladstone.) It has been objected to your system of placing red buoys on one side, and black buoys on the other, that the red buoys are not to be distinguished from the black in twilight; indeed I have heard it stated by scientific men that red is not very discernible in a faint light: are you aware of any practical difficulty having thus arisen?—None, for there has been no complaint whatever of the system; I may mention that several improvements have been suggested, but in consequence of the disapproval of the Trinity House the Commissioners saw that it was of no use proceeding any further at present until matters were brought into some kind of shape, in fact until this Commission should have reported. The improvements which have been suggested are amongst others the numbering of the buoys with large numbers, so that a man when he gets into a channel has only to lower his boat and send to the buoy and ascertain the number, when he knows exactly where he is. That is one recommendation, but I have had no complaints of the red colours with the exception of the conversation that I had with Captain Sullivan, who approved of the system of beacons and buoys being uniform, but proposed to change the colours.

805. Have you made any experiments on Herbert's buoys?—We have had one in use for several years, but we do not approve of it; we find them ride heavily, and they drag very much.

806. (Captain Ryder.) Do they drag or break?—Both; I know that we have had to bring up a buoy from its moorings and to put another one down; that is in the Firth of Forth.

807. (Mr. Gladstone.) Have you applied the same system to beacons that you have applied to buoys?—No; that is a very difficult subject, to indicate by colour on which side the beacon should be passed; we have in narrow channels adopted the system, for example, in Loch Fine.

808. (Captain Ryder.) Are you the author of a Code of Tidal Signals for day and night?—Yes.

809. Will you be so good as to send a copy to the Commissioners?—Yes.

810. (Mr. Gladstone to Mr. Stevenson.) You em-

ploy in several instances revolving lights alternately red and white, and on the side that shews red you place a larger number of burners: have you reason to think that this obviates the difficulty arising from the reduction of the light by means of the absorbent red glass?—Yes; it is possible to equalize the beams, for it was done at the Bell Rock, where experiments extending over four years shewed, that as viewed from Arbroath, 12 miles off, there were only four nights each year on which the white light was seen when the red light could not be seen; but by equalizing the beams you restrict the power of the white light, and in some situations it may be more advantageous to adopt the more powerful white beam so that the light may be sooner picked up at a distance, and the weaker red beam be seen on a nearer approach, when the light appears red and white alternately. This is a well-known principle widely recognized in lighthouse engineering, in particular in the French fixed light, varied by flashes and all such arrangements where lights of unequal intensity are employed.

811. (Chairman.) When in Edinburgh last you called my attention to a notice by M. Regnaud and M. Degrand in the "Comptes Rendus," as to the penetrating power of red and white lights under certain conditions, as far as my memory serves me it was made out by those gentlemen that the conditions would not be very difficult, under which the red might be made to penetrate under certain circumstances even beyond the white light?—I believe it to be perfectly possible, to make the red penetrate further than the white; but to effect that you must necessarily employ a very weak white light. The statement that they make is that having a red and white beam of equal intensity the red beam has a greater penetrating power than the white beam.

812. What is the proportion of red which is necessary to give equal intensity?—We have found at the Bell Rock five to three, as formerly communicated to the Commissioners. The five are 21 inch reflectors, and the three 25 inch, the burners all the same size, but it depends on the kind of medium employed.

813. What is your opinion of the effect at the horizon?—I have no doubt that, at the horizon, in some particular states of the atmosphere, the white light will be seen before the red light, but practically speaking, I think it is a red and a white light, and is so seen for all practical purposes.

814. What is the proportion at Cape Wrath?—There the white beam is stronger; but if the light now building at Butt of Lewis was made revolving it would be necessary to equalize Cape Wrath, which would then be regarded more as an inner or subsidiary light.

815. (Mr. Gladstone.) Have you any red and white revolving dioptric lights?—No. Hitherto no red and white revolving dioptric lights, with one great central lamp, so far as I know, have been constructed.

816. (Capt. Ryder.) Not even in France?—No, not that I am aware of. They have fixed lights varied by red flashes.

817. (Chairman.) In the return sent to this Commission from Edinburgh there is a report of yours and your brother's, of experiments on red lights. Have you made any further experiments since the date of that report?—None. We considered that we had arrived at a satisfactory result, as to the best method of producing a red light in a first class fixed dioptric apparatus, and that it was unnecessary to make any further experiments.

818. (Capt. Ryder.) That was on the best kind of red glass?—Yes. By using bright red chimneys of homogeneous gold ruby glass, for first order dioptric apparatus, instead of panes of red glass, which formerly were used, and applied to the windows of the lantern, the objection to that being that there was condensation between the red and the white glass, and that interfered very much with the light.

819. What, in your opinion, is the most powerful illuminating apparatus for the exhibition of a re-

volving light?—The best apparatus in use is the Holophotal revolving apparatus, as exhibited at North Ronaldsay and Whalsey.

820. Can you furnish the Commissioners with any statistics, showing the value of this Holophotal arrangement, in comparison with the ordinary catoptric or dioptric apparatus, the consumption of oil being the same?—Not exactly, but according to the experiments and calculations we have made, we conclude that the upper and lower Holophotal panels on each face of the apparatus are together nearly equal in power to the lens, thus nearly doubling the light in each flash, an increase which is very much greater than that due to the corresponding auxiliary portions of the catadioptric light, even in the most improved form, the consumption of oil remaining the same.

821. How many intermittent lights are there in Scotland?—Three.

822. Is there not a necessary loss of light from adopting this principle, and, if so, how much?—The intervals are $2\frac{1}{2}$ minutes light and half a minute dark, so that one-sixth of the light is lost.

823. Was this method adopted for the purposes of distinction only?—Yes. The light exhibited has the same intensity as a stationary catoptric light, and is thus preferable to the fixed red as a distinction.

824. Would you now in any new works adopt this principle?—Not if it could be avoided, but still it is preferable to a fixed red light; and there is no doubt that the intermittent is a distinction which shows very well.

825. (*Chairman.*) Are the Commissioners of Northern Lights at all in favour, or have they considered the propriety of introducing gas where practicable?—Yes; that has been brought before them, and has been considered, but the difficulties of establishing a gas manufactory at almost any of the northern lighthouses is such as hitherto have rendered it impossible for them to adopt it.

826. Then I may assume that where it would be practicable there is at present no objection?—No objection whatever.

827. Of course if the gas were not manufactured specially for the lighthouse, but could be obtained from a neighbouring source, it would be cheaper than oil?—Yes, perhaps it would; but it would be necessary, of course, still to be prepared with a lamp in case of gas failing.

828. (*Mr. Gladstone to Mr. Cunningham.*) You have furnished the Commission with details of the expenses of the different lighthouses in respect to the cost of repairs and building; the cost of the repairs of the illuminating apparatus, the cost of painting, oil and wicks, the keepers' salaries, and you have furnished us with the total expenditure for each lighthouse for 1858. Now, on comparing the sums of those items with the total expenditure, I find a great discrepancy; for instance, the average expenditure of the first order of dioptric lights in Scotland I find to be 380*l.*, while the sum of the items is, on the average, only 263*l.*; to what is the remaining 117*l.* due?—There are various sums included in the total account which are not included under any of the separate items, such as rent of ground, allowances in place of ground, boat attendance—a heavy item, and several others which make up the difference.

829. (*Capt. Ryder.*) What is the expense of the management of the Scotch lighthouses?—In reference to the revenue of the Board I make it to be about 2 per cent.

830. Can you give us the items?—Yes. Salaries of the establishment for ordinary management, stationery, &c. This statement has been made already to the Commission in reference to Captain Sullivan's evidence, that the expense of management by the Commissioners was 16 per cent. upon their revenue.

831. (*Chairman.*) Does that include expenses for collection?—I cannot imagine what is included under the 16 per cent.

832. Have you got as a separate item the expenses of collection?—I think so; but our expenses on this head are not above 50*l.* a year. The collectors are

now forced to collect the light dues without any remuneration.

833. While on the subject of expense, from the length of time that you have been secretary to the Commissioners of Northern Lights, you can probably state to this Commission how much the correspondence of your office has been increased in consequence of the system established by the provisions of the Merchant Shipping Act, and to what extent the office is charged with the expense consequent on such an increase of correspondence?—The increase of the correspondence has been very great, and probably the correspondence with the Board of Trade itself amounts to all the others put together, but the increase, beyond the stationery, has cost the Board nothing.

834. (*Captain Ryder.*) What power of interference have the Commissioners in Scotland with the local authorities, in the matter of lights, buoys, and beacons?—The Commissioners have power, with the sanction of the Board of Trade, under the 394th section of the Act, to compel any local authority to remove or discontinue the lights; and no local authority is to erect, or discontinue or remove any lights, without the authority of the Commissioners.

835. Do you, under that clause, take a power of inspection?—No, we do not conceive that to be conferred.

836. Do the Commissioners think that such powers might be beneficially conferred upon them?—The Commissioners did think so; and they proposed clauses to the Board of Trade upon the introduction of the first Merchant Shipping Act, which they declined to adopt. I will send you the clauses.

837. Have you frequently been called upon to exercise the powers which you say the Commissioners have under the Act; the limited power of interference?—We have had numerous applications from local authorities for authority to exhibit their lights, and which the Commissioners have sanctioned, either with or without modification.

838. Do you know of any cases in which tolls are levied for lights by local authorities, and where no light is exhibited?—I think there are some cases of tolls being authorized to be levied by local authorities, who are directed by the Acts to erect lights, and which is not done; but I am not aware that any specific toll for lights is authorized to be levied, or which are levied without there being a light.

839. Does not the Act that you refer to, give power to local authorities to place their lights under the control of the Commissioners for Northern Lights?—Yes, by section 395, if any local authority fails to obey any direction.

840. That empowers you to take it from them?—Yes.

841. Therefore their power is to be exercised whenever the local authority fails?—Yes. They have only to fail, and for the Queen on the application of the authority to say that we are to take up the matter.

842. Has this power been exercised?—No.

843. In no case?—I do not know that it could be called the exercise of a power; but we have arranged for assuming the Douglas Head Light, at the Isle of Man. Certainly, under those clauses, by arrangement with the Commissioners of Harbours, and the Board of Trade have sanctioned a toll for the public light, and we levy that toll.

844. Have you any power under the Act, to oblige a local authority to put in an efficient state any buoy?—I do not think so. That question arose the other day in the Solway Firth, where the Commissioners upon the occasion of visiting a lighthouse there, were very much struck with the inadequacy of the buoys, and they applied to and obtained the sanction of the Board to call upon the authorities to put their buoys in a better state. It then appeared that the buoys were beyond the limits of their harbour in the open sea, where they had no right to be placed, and the Commissioners then said that the only thing to do was for them to assume them. The Board of Trade have decided that they are to be left alone.

A. Cunningham,
Esq.
D. Stevenson,
Esq.
23 Jan. 1861.

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D. Stevenson,
Esq.

23 Jan. 1861.

845. (*Chairman to Mr. Stevenson.*) Can you state generally what the differences are which have arisen between the general authorities on the character of the Rhu Vaal light?—The Commissioners of Northern Lights considered that it was unsafe to show a light through the Sound, between Oronsay and Islay, so as to open it, in consequence of the intricacy, shoalness, and hazard of the navigation. The Board of Trade took another view, and conceived that it would be advisable to open up this passage, and accordingly the light was placed in such a situation, and at such a height, as to enable us to do that. A plan was proposed for opening up this channel, and the matter was referred to the Trinity House, and the Trinity House agreed with the Commissioners for Northern Lights that it was not advisable to open up the channel as a navigable channel, but they believed it would be advisable to show a light through this channel as a danger light. The Commissioners remained of opinion that it would be better not to throw a light through that channel at all, so as to run any chance of leading vessels towards it; but they said that now that a light was erected there, and that the light was to be shown, it ought to be a distinct danger light,—a red light; the Trinity House and the Board of Trade both agreed that it ought to be a white light, so as to show as far as possible, and to warn all vessels of their approach towards this passage. The light was accordingly arranged in accordance with the directions of the Board of Trade and the Trinity House, and made so as to show a white light through the passage and a red light towards Colonsay, and the no-ices were drawn accordingly. The Commissioners pointed out that if the notice, as drawn, remained as it was, that part of the red light would be seen over the island of Oronsay, and might occasion inconvenience or danger. The notice was accordingly altered, and so the light remained. Subsequently to its exhibition, Captain Bedford wrote to the Commissioners, and to the Admiralty too, I think, to state that two vessels had been misled by seeing this light over the land. This was represented to the Board of Trade, and the Commissioners received directions to alter the light after its exhibition, and to mask it, so that no red light should be seen over Oronsay; that alteration was made, and the light was re-advertised. But, even as exhibited now, it is not in accordance with either of the views held by the Commissioners, which were: first, that the light should not be shown through that passage; and, second, that if it were, it should be red and not white.

846. In the additional correspondence, regarding Rhu Vaal, which the Secretary has placed before this Commission to-day, there is a notice to mariners as to the character of this light, in which notice it would appear that the white light to the eastward is to be a leading light, and the white light to the westward a danger light. By whom were those instructions drawn up?—By the Trinity House, I believe.

847. Then is it the custom of the Trinity House to draw up directions generally as to all lights, whether under the Commissioners of Northern Lights or Irish or English lights?—No.

848. You have stated that the shewing of a white light, for the purpose of opening up the passage, originated with the Board of Trade; where does it appear in the Merchant Shipping Act that the Board of Trade have the power of originating any proceeding?—It originated in the form of a suggestion, which I think the Board of Trade have the power to make.

849. (*Captain Ryder.*) Are the Commissioners to understand that the light, as now exhibited at Rhu Vaal, carries out the wishes and intentions of the Board of Trade, which was to light up the Sound of Oronsay and invite mariners into it at night, and also carries out the intentions and wishes of the Trinity House, by acting as a danger light, to warn mariners out of the Sound of Oronsay, and is in direct opposition to the views of the Northern Commissioners shewing a light through the Sound of Oronsay, which

they thought should be kept dark, and by being a white light instead of a red one, as is the practice of the Northern Commissioners in all other parts of Scotland?—The only thing is that of course it is not a leading light, inasmuch as they have distinctly stated in their notice that it is a warning light, and the Board of Trade have in point of fact, for the present at least, agreed to the suggestion of the Trinity House that it ought not to be a leading light but a warning one, and so far the Board of Trade have deferred to the opinion of the Trinity House as the light now stands; both having gone against the opinion of the Scotch Commissioners.

850. (*Chairman.*) So far as it appears to this Commission, the Northern Commissioners need not have existed at all, so far as carrying out their views are concerned in this particular instance, for the Trinity House and the Board of Trade have done the thing for them?—That is practically the state of the case in the instance of Rhu Vaal; they altered the site, they altered the height, and they altered the character of the light, and they drew up the sailing directions.

851. (*Captain Ryder.*) Will you furnish this Commission with a list of the principal works in which you have been engaged?—I carry on business in partnership with my brother. We are joint engineers to the Commissioners of Northern Lighthouses. We have also acted for many years as consulting engineers to the Board of Works at Newfoundland, and designed and superintended the execution of lanterns and apparatus for six lighthouses for that country. We also designed the apparatus for the Horsburgh lighthouse at Singapore, and are now advising as to the erection of two lighthouses in India. We also act as engineers to the Fishery Board, and have executed harbour works for that Board on all parts of the coast of Scotland, there being very few harbours in Scotland on which we have not been employed. We acted as engineers for the improvement of the navigation of the rivers Ribble, Dee, Lune, Tay, Forth, Fossdyke in Lincolnshire, and others. We have also been extensively employed as harbour engineers both in England and Ireland, and have been employed by the Admiralty, the Treasury, the Woods and Forests, and other public boards and private companies.

Adjourned.

STATEMENT by the Sheriff of Ayrshire to the Royal Commission on Lights, &c.

I avail myself of the permission of the Commissioners to give an explanation and statement of the Scottish Lighthouse administration, which has been the subject of severe and unjust animadversion by Captain Sullivan, the nautical adviser of the Board of Trade, in his evidence before a Committee of the House of Commons on Merchant Shipping.

The general purport of his evidence is that the Scottish Board is not qualified for discharging its duties, and that in its conduct it has been the cause of both serious expense and of trouble to the Boards associated with it. A most unfavorable contrast is also presented of the Scottish Board and its management with those of both England and Ireland, describing in particular its rate of expenditure as 50 per cent. more than that of England, and 100 per cent. than that of Ireland.

Perhaps the best general answer to this general attack is to refer to the condition of the Northern Lighthouses and of the establishment as they fell under the observation of the Royal Commissioners. If they were found to be inferior to those of England and Ireland let them be condemned, but if equal, still more if superior, the sweeping condemnation of Captain Sullivan can be regarded as neither correct nor just.

2nd. In regard to his special objections, the first is as to the composition of the Scottish Board, as consisting of lawyers solely in its attending members, who are called on to decide questions upon which alone it is said a nautical man is competent to give an opinion.

The Board, it may be mentioned, consists of the Lord Advocate and Solicitor General, the sheriffs and chief magistrates of the principal maritime counties and cities of Scotland, and comprises among its former members eleven out of the thirteen supreme judges.

The first answer to Captain Sullivan's remark is, that if his criticism is just, this evil has been augmented by the Board of Trade in injudiciously depriving the Scottish Board of their *salaried* engineer, who used to be present at every Board meeting. With his great experience and intimate knowledge of everything relating to Lighthouses, Mr. Stevenson was an adviser equal at least to any nautical man.

It may be stated that the Northern Light Commissioners have never been insensible to the value of nautical opinions, and that before being placed under the Board of Trade they invariably, prior to erecting a Lighthouse, took into consultation the most experienced navigators they could procure in cases of any difficulty.

The objection of Captain Sullivan to the constitution of the Scottish Board is the more extraordinary that it applies with even greater force to the Board of Trade, of which he is the adviser, seeing that its members are also civilians, with various and important duties to discharge, and subject to such frequent changes as to place them at great disadvantage in acquiring a sufficient knowledge of Lighthouse administration. In eight years there have been six Presidents of the Board of Trade, giving only an average of 16 months attendance to each.

The constitution of the Board of Trade is considered to be one great cause of the evil and differences which have arisen for the necessary consequence of the various duties of its frequently changing members is that a great deal too much authority is unavoidably devolved on their naval adviser, who, the Scottish Commissioners are given to understand, transacts the greater part of the business, giving orders in engineering matters out of his sphere, and corresponding always in name of the Board. It is obvious if this statement be correct, of which the Royal Commissioners may satisfy themselves, that it is an extremely inexpedient arrangement giving the nautical adviser too much unacknowledged power, and enabling him, when writing in the name of the Board, to avoid a free discussion as well as the publicity and consequent open responsibility for his individual management and correspondence.

It has always been felt an extremely delicate thing to comment on communications nominally from the Board, but which the Scottish Board believe to be exclusively of the naval adviser.

The evil of an anonymous or undisclosed individual exercising such extensive powers is so great that the general opinion is that the control over the Lighthouse Boards would be more properly entrusted to a special British Commission or to the Board of Admiralty rather than to the Board of Trade.

In the case of the Admiralty there would be a mixed board of naval men and civilians, all acting in their own proper names, and with avowed responsibility.

3rd. It cannot be admitted that civilians are unfit to discharge their duties as Commissioners of Lighthouses. It may be conceded that they are not so well qualified as naval men to point out in the first instance the sites for Lighthouses and Beacons, but on the other hand it is not a very recondite matter to weigh and to decide upon the evidence regarding sites when there is difference of opinion.

If, however, there is any force in the objection to the competency of the Scottish Board, it applies even more strongly to the interference and orders of the Board of Trade through their successive naval advisers in matters where neither they nor any other unprofessional man can possibly have the necessary knowledge.

Reference is here made to their opinions and dictation as to buildings, the plans and estimates, the structures, whether they ought to be of masonry, iron, or the like; the materials, whether of stone, and the

description of stone or brick &c.; the roofs, whether to be of lead or slate.

It is needless to point out how injurious to the Board of Trade as a board of control and authority, such interference in details must be. It is indeed scarcely credible that the Messrs. Stevenson, men of undoubted eminence, and at the very head of their profession as lighthouse engineers, should in their own department be controlled and overruled, and have their plans and works altered by a single naval gentleman.

Then, upon the point of expense, Captain Sullivan in his evidence censures the Scottish Works as more expensive than either the English or Irish, and in proof of that quotes the expense of some Harwich buildings for a light where there is no tower, and contrasts the cost with the cost of a Scottish *complete* lighthouse and all its appendages at Holborn Head and he repeats the contrast in the case of a proposed lighthouse on the most outlying of the Monach Islands, where there is neither stone, sand, lime, nor even water, and no inhabitants.

There is evidently in such matters *no one point* of resemblance. As well might the cost of the Harwich buildings be compared with that of the Bell Rock or Skerryvore Lighthouse.

4th. Some notice is now required of the special differences between the Board of Trade and the Scottish Board, of which the two most important instances relate to the Flugga, or North Unst Lighthouse, and that of Whalsey, to which Captain Sullivan in his evidence is understood to allude in terms disparaging to the opinions of the Scottish Board.

In regard to North Unst, the subject is fully before the Royal Commissioners, and need not be resumed here, further than to say, that the Scottish Board considered the site of Lambanness to be preferable to that chosen for the Lighthouse, even though it could have been constructed at the same cost, and in this they were confirmed by their engineer and by the unanimous opinion of the shipping interest of Peterhead, Aberdeen, Hull, Leith, &c., whose commanders of ships are the chief navigators of these seas, and are of a class comprehending such men as Scoresby, Penney, and others.

But the excess of cost of building on the site chosen was more than 20,000*l.*, the actual sum expended being about 32,000*l.*, while Mr. Stevenson's estimate for a light on Lambanness was 10,000*l.*

4 To a person accustomed to give due weight to the opinions of those differing from him, it would have occurred as a more judicious course not to incur an extra expense of 20,000*l.* (which would have sufficed to erect two additional lighthouses), where competent judges actually preferred the Lambanness site as preferable in a nautical point of view, but it cannot be disputed, that in a case where there were such authorities on either side, it was a most unfortunate instance to be selected as a proof of the actual incompetency of the Northern Lighthouse Board.

5th. As to Whalsey, the difference of expense (above 8,000*l.*), was greatly in favour of the site advocated by the Commissioners. It is true that Admiral Beechey's site was about 700 yards more in advance, but it must be kept in view that the object of this light was not to point out any particular rock or local danger, but to indicate the geographical position of the great group of islands called the Outer-kerries of Whalsey, and to enable vessels to give them a *large* offing. Moreover, the tower on the Inner Island as suggested by the Commissioners, while answering equally well all the purposes of that forced on them at an extra cost by the Board of Trade, would have opened up from its superior height a larger space of sea. On both questions, the Royal Commissioners have full evidence before them, and are the best judges of the controversy; but it does seem a strange conclusion at which Captain Sullivan arrives, that the Northern Commissioners are the opponents of economy, and the advocates of useless expenditure. As an element for judging on the subject, it may be stated that the sacrifice of cost made in selecting the present sites of the two light-

*Commissioners
of Northern
Lighthouses.*

houses in question over those submitted by the Commissioners, is not less than 30,000*l*. The additional cost of building is 30,000*l*, and the additional annual expense of maintenance will be 600*l*. per annum at Unst, and 400*l*. at Whalesey, which is equivalent to a capital sum of 20,000*l*. at least.

6th. There is another lighthouse, that of Rhu Vaal, in the Sound of Islay, regarding which great differences of opinion have arisen on several points between the Board of Trade and the Scottish Board, in which the former seem to be clearly in error. The whole of the discussion on this subject is also before the Royal Commissioners, from which they can form their opinion, and it is thought that they will not hesitate in deciding that the change of site and consequent raising of the lighthouse tower, at an extra cost of 1,500*l*., so as to admit of being seen through the sound, and its being made visible across to Oronsay, was injurious, and that from the same lighthouse to shew a white light to indicate that one passage was safe, and that another was dangerous, has a great tendency to mislead vessels.

7th. There has been a stop put to the erection of several lighthouses, viz., one on the Iron Rock in the Sound of Jura, another on Holbornhead (though this last is now conceded), a third on Stourhead in Sutherlandshire, for reasons of the most unsatisfactory character.

At Holbornhead the proprietor claimed compensation for his ground, and that a road should be made from the neighbouring harbour of Scrabster. He offered a reference of the former point to arbiters, and the Commissioners recommended the acceptance of his terms to the Board of Trade. The Board of Trade, however, thought the proprietor's demands were unreasonable, and after a lengthened correspondence on this subject, the erection of the lighthouse was on this ground indefinitely postponed, the necessity for the light having been admitted. Surely this was a great mistake.

After a delay of three years the lighthouse has been sanctioned by the Board of Trade, and the proprietor's claims have been virtually acceded to. It has now been contracted for.

In regard to the lighthouse on the Iron Rock, the reason for suspending it is equally groundless. The necessity for a lighthouse has been admitted, and the plans have been approved of, and submitted with an estimate to the Board of Trade, but while the plans were approved of, the estimate was objected to as too high, and the Commissioners were required to give lower estimates. Messrs. Stevenson stated that they could give a cheaper plan, of an inferior description, but that they could not estimate the cost of the approved plan at a less sum than they had mentioned. The Board of Trade reject the inferior structure, but insist upon lower estimates, and thus the erection of the lighthouse has been suspended upon the most insufficient ground. It is not the estimate whether high or low, but the contract price which regulates.

Most people, when building, prefer to have full and safe estimates.

When the high reputation of Messrs. Stevenson, as lighthouse engineers, equal to that of any engineers in the world, is considered, it is a singular mark of distrust not to proceed upon their estimates, but rather to leave for an indefinite time the coast unprotected.

8th. Two recent acts of the Board of Trade are deserving of notice, as exercising an undue control over the Scotch Board. On opening up the tenders lately, Messrs. Stevenson recommended in two instances that the lowest offer should not be accepted. The Commissioners gave effect to their recommendation, proceeding on the ground in one instance, that they were satisfied from the lowness of the tender, that the contractor must have made some serious error in his calculation, and in the other, that they did not approve of the contractor.

The Board of Trade altered the decision of the Scottish Board, and appointed the lowest tenders to be accepted. What is the use of an engineer, if his opinions on such points are to be disregarded?

After the contractors' offers were accepted by the Commissioners under the direction of the Board of Trade, the one contractor acknowledged having made an error, and was liberated, while the other asked leave to withdraw, which was granted by the Board of Trade.

9th. One other topic remains relative to Captain Sullivan's statement that the Irish buildings are cheaper than those in Scotland. The subject was slightly touched upon before, in regard to the cost of the Harwich buildings, but the present remarks apply to the general contrast between the expense of buildings in Ireland and in Scotland, which is represented to be 100 per cent. cheaper in Ireland. Inquiry has been made, and the report to the Board of Northern Lights is, that taking buildings in localities which admit of comparison, the Scottish buildings cost actually less than those of Ireland. That result was intimated to the Board of Trade, and was neither admitted nor denied.

Silence in relation to so grave an animadversion was not the proper mode of disposing of it, and the fact goes far towards settling the complaint of improper interference by the Board of Trade, or their officials.

In Captain Sullivan's evidence there is a statement by him to the effect of the accommodation given to the lighthouse keepers being unnecessarily large as well as fine in the workmanship. So far is that from being the case, that the houses recently built with three rooms and a kitchen, and without proper outdoor conveniences are not sufficiently commodious. Of this the Commission can form a judgment from their own inspection. One thing at all events is clear enough, that to describe these dwellings to be like gentlemen's houses is more of the nature of a figurative expression, than of evidence to a fact.

There is given in an Appendix a statement furnished at the request of the Commissioners, by Messrs. Stevenson on the result of the recent improvements in lighthouse illumination, which have been made for the Board.

In conclusion, it may be observed that the great object of the Board of Trade, or their advisers, seems to be to consult an economy (it is thought a false economy) in mere original outlay without due consideration of the solidity and permanence of the work.

The Northern Lighthouse Board have ever been studious of true economy, and as instances they may refer to the avoiding the waste of light by the use of the mechanical lamp of Fresnel, instead of the lamp used in England and Ireland, and to the abridging of the daily period of illumination of lighthouses founded on observations by their engineers of the precise time when they become or cease to be visible, instead of adopting the period from sunset to sunrise.

JOHN CHRISTISON.

We concur in the above—

GEORGE DINGWALL FORDYCE,
Sheriff of Sutherland and Caithness.

THOMAS CLEGHORN,
Sheriff of Argyllshire.

E. D. SANDFORD,
Sheriff of Wigton and Kirkcudbright.

I concur generally in the preceding statement,

F. BROWN DOUGLAS,
Lord Provost of Edinburgh.

NOTE as to IMPROVEMENTS ON LIGHTHOUSE ILLUMINATION peculiar to the Northern Lighthouse Board, by which a saving of expenditure is annually effected.

Having been instructed by the Board to report on these improvements on Lighthouse Illumination, by which an annual saving is effected, and which are believed to be still peculiar to the Northern Lighthouses, we now beg leave to submit the following statement.

We do not think it necessary to do more than allude to the introduction of the holophotal system, by which the principle of total reflection was applied to revolving lights, or to refer to other improvements tending to increase the efficiency of the lights, as those plans are now in general use. We pass on, therefore, to the following annual savings which have been effected by the adoption of improvements which are perhaps still peculiar to the Scotch Lights.

1st. By a system of tables furnished to each Light-house, by which the unnecessary burning of the oil during daylight has been prevented. The system (elsewhere adopted) of lighting at sunset, and keeping the lamps burning till sunrise, occasions a needlessly large expenditure of oil in our northern latitude. During the long periods of twilight, more especially in the summer months, there is broad daylight, which not only renders Lighthouses unnecessary, but even though they were at such times necessary the light emanating from them is not visible at any considerable distance. The tables furnished for the guidance of the lightkeepers are calculated for every day in the year, and are based on actual observations which were made at different lighthouses on the times after sunset, when certain distant objects ceased to be visible. By the adoption of this plan an annual saving results of not less than 1,600*l.*, representing at 5 per cent. a capital sum of 32,000*l.*

2nd. By the adoption at Stornoway Bay of an *Apparent or Beacon Light*, placed on Arnish Point, and lighted by a strong beam of light thrown from a lighthouse on the mainland, nearly the same efficiency

has been secured as if the tower had been erected on Arnish Reef itself, which is a sunken ledge of rocks projecting from the shore into the fairway which leads to the bay or anchorage.

The petitioners for the Stornoway Light were of opinion that the tower should be erected on the Arnish Reef, but the apparent light has answered every purpose, and a saving has in this way been effected of at least 3,000*l.*, which, at 5 per cent., gives an annual saving of 150*l.*

3rd. By the adoption of the plan of *Azimuthal Condensing Lights* at Kyleakin, Oronsay, Sound of Mull, Carran Phladda, and McArthur's Head, a great saving has been effected. The practical effect of this arrangement is, that with a burner consuming but a small quantity of oil, a light is obtained in the only directions in which great power is required, equal to a first order light. Taking the most limited view, the saving, on the supposition that reflectors were used to supplement a light of the common kind in particular directions would amount to 384*l.* 14*s.*; but as at four of the stations above named, there is reason to doubt whether reflectors could (owing to local peculiarities) be applied at all, the total saving would amount to 855*l.* per annum, representing the capital sum of 17,100*l.*

From the above statement it appears that the Northern Lighthouse Board has, by the adoption of improved methods of illumination, been enabled to effect an annual saving amounting, on the most moderate supposition, to about 2,000*l.*, which represents the capital sum of 40,000*l.*

A. Cuningham,
Esq.
D. Stevenson,
Esq.

23 Jan. 1861.

Friday, 1st February 1861.

PRESENT :

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON, R.N.
JOHN HALL GLADSTONE, Esq.
SAMUEL ROBERT GRAVES, Esq.

Rear-Admiral WILLIAM ALEXANDER BAILLIE HAMILTON in the Chair.

Captain BARTHOLOMEW JAMES SULLIVAN, R.N., examined.

852. (*Chairman.*) You are the professional member of the Board of Trade?—Yes.

853. How long have you been in that position?—Four years.

854. What do you consider to be your position at the Board of Trade with respect to the management and control of lighthouse authorities?—I am the professional adviser of the President of the Board of Trade on all points that may be considered nautical and professional connected with lighthouse authorities, and pilotage authorities.

855. The Commission will be obliged to confine their examination of you to this day, as time is pressing, and they are desirous of presenting their report to the Queen as soon after the meeting of Parliament as possible?—As I have had notice only since yesterday afternoon I have had very little time indeed to go through the evidence* in order to be prepared to answer such parts of it as I feel require to be answered.

856. With reference to your letter of last Wednesday, requesting that you might be examined by this Commission, it is right I should state, that it has always been our intention to examine you, but we deferred doing so until the evidence from the lighthouse authorities was in print, so that the officers of the Board of Trade might see that evidence, and have an opportunity of making any statement that it might be thought desirable to make. If you have seen that evidence, although you may not have had much time to go into it, and have any obser-

vations to make upon that evidence, the Commissioners will be glad to receive those observations now?—I will confine myself to a few principal points, as I really have not had time to make all the observations that I should have wished to make on the evidence, and which I think are necessary. I will begin with the evidence of Sir James Donbrain, and will refer, in the first place, to question 145, which relates to the fitness of the "Midge," schooner, for the duties she had to perform.

857. Do you call her a schooner?—Yes. It is stated in the evidence that she is wholly unsuited for the purpose for which she was intended, because she could not tow the "Kish," light vessel; and it is also stated, in answer to question 147, that the Board of Trade did know that she was required to perform that duty, that is, to tow light vessels. I must give first the most positive contradiction to that statement, and I will briefly state what gave rise to this vessel being built. The duties of the buoy service had been performed by a small sailing buoy vessel; they required a new vessel, and without alluding to a steamer at first they asked our consent to a sailing schooner of 100 tons for the buoy service, and exclusively for the buoy service; that was immediately sanctioned, tenders were obtained, several of which were sent in from good builders for a schooner. Before any final steps were taken,—and in the first instance, privately between myself and Captain Roberts—Captain Roberts, either personally or by note, told me that he should be very glad, or that the Bal-

Capt. B. J.
Sullivan, R.N.

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* The oral evidence of the three lighthouse authorities.

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last Board would, if they could get a small engine put in the vessel, so that a small auxiliary screw vessel might be had instead of a sailing schooner, in order to facilitate the buoy service. After discussing it with him, and thinking it a reasonable proposition, as they had no steam vessel on that coast, and particularly because I thought that a sailing vessel would be comparatively useless when the water was calmer and more smooth, which would be the very best time for examining and shifting the buoys, I first spoke to the President about it, and asked him to sanction an increased estimate for a steam vessel instead of a sailing vessel. Having arranged that this should be sanctioned, application was then officially made, which was of course sanctioned, and the first estimates I think that we received from our own surveyor, or from Captain Roberts—I do not remember which—were for 3,500*l.* for a small screw schooner instead of about 2,000*l.* for a sailing schooner. We asked them to try for tenders for building this vessel, if they wished it, in Dublin, or we would obtain them for them in London, and we offered them the assistance of our surveyor for the purpose. This was principally done privately between myself and Captain Roberts, who had come over as agent for the Ballast Board; but, on examination, it was found that we could only, for the sum fixed upon, obtain a vessel of the second class, that although the frame would have been equally sound she would have to be planked with inferior material, and would not therefore have been a first-class vessel. Upon that a requisition was made that an increased sum—from 3,500*l.* to 4,000*l.*—might be sanctioned, in order to have a first-class screw schooner instead of a second-class one. I should like to show the Commissioners how perfectly wrong the statement was, but which was apparently confirmed by the Earl of Meath, that we refused the additional sum in order to furnish them with a better vessel. I will just read one sentence to show this: “In reply, I am directed to acquaint you that their lordships have no objection to expend the sum of 4,000*l.* in order to obtain a “first-class vessel.”

858. (*Mr. Graves.*) What is the date of that letter?—The 31st October 1857. We go on to say that tenders have been obtained from Mr. Langley, a builder in London, and which have been the lowest, who was ready to complete a vessel of that class for about that sum of money. No other request, that I am aware of, was ever made by them for a better vessel. Every request relating to her was complied with from the first—from a sailing schooner to a steamer—and again from a second-class vessel to a first-class vessel; but throughout the whole there never was the slightest allusion to her being fit for towing light vessels. On the contrary, the buoy service was alone alluded to; and I know that at the time the City of Dublin Steam Packet Company had a contract with them, which was never altered, to tow light vessels with one of their steamers whenever required; and I was therefore perfectly surprised when I saw that an attempt had been made to tow a light vessel with a little schooner of 25 horse power. I think that the Commissioners will see the very great difference between a vessel being fit for the buoy service, which had been previously done by a little vessel of 60 tons, and a vessel that was fit to tow light vessels in that sea.

859. It was before you became the professional member of the Board of Trade that the *Argus* Irish steamer was sold?—It was.

860. Then you cannot probably inform this commission why she was sold, or answer the question that we are desirous of having answered, whether it would not have been the more advantageous course, seeing that the *Argus* had been built and paid for, and was peculiarly adapted for the service for which she was intended, if the Irish Board had been compelled to use her, and employ her for the purposes for which she was built, rather than that she should have

been sold at the end of 3 or 4 years at a sacrifice of a sum of 8,000*l.* or 10,000*l.*?—Not having been engaged in the matter, I cannot of course answer positively; but after I had come to the Board of Trade, and an application was made by the Ballast Board for a new steamer, irrespective of the *Midge*, for a new large steamer; not knowing what had occurred about the *Argus*, I gave a very decided opinion that a steamer was even more required for Ireland than for Scotland, as they have many more lights and light ships,—of which the Scotch have none,—and more buoys, and I recommended that the request should be complied with. But when I spoke to the president and secretary about it, I found that they had had a steamer, and that she had never been used for the purpose for which they professed to want one, and that she had been sold in consequence of suggestions emanating from their own body to the President of the Board of Trade; that of course altered my opinion, and I could not then have recommended that those who having the steamer, and had not used her, and who themselves suggested that she should be sold, at a great sacrifice, should again come to have a large sum taken out of the Mercantile Marine Fund to supply them with a steamer. With respect to the power that we had to make them use their steamer, I doubt whether any such power is given, as long as we could not show that the lights were inefficient, or that some work had been neglected; our power has reference to controlling the expenditure, and as less was perhaps being expended by the vessel lying there, although it prevented their having a sufficient inspection of the lights, I do not see how we could have interfered to say how they should do their work; for that certainly would have been carrying interference far beyond what has been strongly objected to as too much interference. The only reason that I see we could have given for it would have been that we had seen that expense was incurred for work that this vessel might have done.

861. (*Mr. Graves.*) You have stated that tenders were made in London; may I ask you whether those tenders were received at the request of the Ballast Board, or by the Board of Trade direct?—So much was done privately between me and Captain Roberts, who came over here with their authority to act, that we were really more assisting them. Our engineer, and shipwright surveyor, gave them all the assistance they could at the request of Captain Roberts, both in designing the vessel and the engines, and obtaining contracts, and in inspecting the vessel when built.

862. Were the tenders referred to received by you direct, or did they go the Ballast Board in Dublin?—The tenders were obtained through our surveyor, I believe, and forwarded to the Ballast Board for their consideration.

863. With reference to the *Midge*; do you consider her thoroughly adopted for a buoy vessel, for the purpose of taking out buoys and replacing them?—I have always considered her so; and when we consider that the same work had been done by a vessel of half her size, and therefore she has much more room for stowage, and in carrying out buoys, in addition to the steam power, which gave her a speed of above eight knots, and she could go out in fine weather when a sailing vessel would have been inefficient; I think there is no doubt that she was far superior to anything they had had before, and perfectly sufficient for the purpose.

864. (*Chairman.*) You have just now spoken of the engineer and shipwright surveyors as having aided you in the specifications and contracts for the *Midge*?—Yes.

865. I think you mean that this commission should understand that the management of lighthouses, and lighthouse business generally, so far as the Board of Trade has to do with it, devolve upon you?—So far

as advising the President on all practical points; but on points connected with the powers given by the Act to control expenditure, he would have the advice of Mr. Farrer and Mr. Booth.

866. Referring to what you said about your engineer and shipwright surveyor; who would you say you had to assist you in the business of lighthouse management at the Board of Trade?—In connexion with the lighthouse work, those persons do not apply at all; it was entirely an extra thing their doing this for the Ballast Board. In connexion with the lighthouse authorities we have only the opinions of their own engineers to guide us. So far as it applies to lighthouses, I think we have means quite sufficient to enable us to form an opinion upon those subjects that we are called upon to form an opinion upon; and I believe that the lighthouse engineers would object to their plans or estimates being submitted to any other engineer.

867. (*Mr. Gladstone.*) When a general lighthouse authority proposes to change a catoptric for a dioptric light, and applies to you for the requisite funds, what determines your approval or disapproval?—In all cases that have occurred of that kind the question for consideration has been whether that light required to be restored. If it was still a good light on the catoptric principle, and did not require repair or restoration on that principle, I should not recommend that the expense of putting a new dioptric light should be incurred. But I think there has been only one instance in which, on those grounds, we have refused. I think one Irish case. Those which the Trinity House, and some which the Ballast Board have asked for, I know have been granted immediately. From the time that I first came to the Board of Trade, and first studied and understood the subject, I have been very partial myself to the dioptric light; and in fact have not recommended the sanctioning of one catoptric light since I have been at the Board of Trade. On the contrary, the first thing I did, after studying the subject, was to stop a catoptric light that had been already ordered for a colonial lighthouse under us, recommending that the engineer should provide a dioptric light; and therefore the feeling has been to encourage the dioptric light everywhere, to sanction no others for a new light, and to sanction no others when a change takes place; that is, not to make a change from a good catoptric to a dioptric merely for the purpose of making a change, if the catoptric light was still in good order.

868. Then do you consider a dioptric light superior to a catoptric light under all circumstances?—I think there are some advantages in it which make it desirable to adopt it in all circumstances where a large arc has to be lighted. If it was to light only a narrow band of light in a channel I would still, for the sake of economy, light it by a reflector and a small lamp; but where a large arc has to be lighted I think there is no question, from the simplicity, more than the extraordinary power of the dioptric light, that it is desirable to adopt it; but it is particularly so with fixed lights, because you overcome the intermittent character of the fixed light, consequent on your changing your position from the focus of one reflector to the interval between two reflectors. If you compare the dioptric light with the catoptric fixed light, when you are in the focus of a reflector, I do not think there is any superiority in the dioptric; but the advantage of a continuous equal light is so great that I should never sanction its being applied any longer to fixed lights. With respect to revolving lights, I have no doubt that a good catoptric light is better for the sailor, in some respects, than the dioptric. The advantage of the slow revolution and the gradual coming in of a fine large light, which shows longer

and goes out again gradually, I think, gives it a superiority over even the longest flash, as you must call it, of the dioptric light. And were one only to consider that point, I think I should still prefer for the revolving lights, where a large number of reflectors was used, a catoptric light. But when you consider the extra expense of maintenance, and the simplicity and facility of keeping clean the glass, instead of having to polish the reflectors, I think that, on the whole, I would decide to give the preference to the dioptric, even for revolving lights. I observe that one witness has endeavoured to create an impression that the Board of Trade had rather discouraged the use of dioptric lights, and I would wish to point the attention of the Commissioners to a paper which was drawn up by my suggestion,—after obtaining the opinions from different Boards,—for the use of the colonies, in order to endeavour to prevent their sending home any longer for catoptric lights, and, therefore, giving a decided opinion in favour of the dioptric light; and it has been only in one case, I think at Cork, where the Irish Commissioners could not show us that the light, as a catoptric light, was a bad one, and was requiring repair or alteration, that we refused the money to place a new dioptric apparatus there. My remarks on this subject now will save me from going into that subject again. The Tory Island light was alluded to by one of the witnesses, and that, I think, is another proof that the witness must have quite misunderstood the whole thing, for he has made a great mistake. The Tory Island light being a great sea light for the Western Ocean, the change was sanctioned, I believe, to a dioptric light almost as soon as the application was made to us—at all events with very little delay—and there has been, as there generally has been, with the Irish Board, unusual delay in carrying it out, after our sanction has been given; but certainly no delay has been caused by us, that I can recollect, in getting the best possible light for Tory Island. I may state, in addition, that I should have hesitated much longer in adopting dioptric revolving lights had we only possessed the original revolving light of Fresnel, as there was not only a loss of light in that light, but a very serious evil, I believe, which I think has not been sufficiently seen by those who fix on the character of the lights, and I was glad to find that Mr. Stevenson confirmed my opinion, which is, that a light should not show a different character at different distances; that whatever the character is that is given for a light, whether you see it first on the horizon or through a fog close to you, that character should never vary. I am, therefore much opposed to intermittent lights fixed and flashing, which some of the French lights, I believe, are. But the original dioptric Fresnel's light was an entirely fixed and flashing light; it gave, at short distances, a fixed light with a flash at intervals, and beyond a certain distance, or in a fog at a short distance, you saw only the flash. When I consulted Mr. Stevenson on the subject, he gave me one instance of a vessel having been lost through that very thing. Mr. Stevenson's beautiful holophotal light having done away with that, and also increased the power of the light in a considerable proportion, has, I think, done away with the objection. Therefore I have no hesitation, if the holophotal light is used, in recommending always that a revolving light, as well as a fixed light should be dioptric.

869. Would you therefore veto any proposition to put up a fixed and flashing light?—Certainly, as far as our power went of objecting to it; but as no proposition of the kind has been made since I have been at the Board of Trade, with the views which I think are now generally entertained, I should doubt whether any proposition of the kind would be made again. I believe that we should confine ourselves to two lights—a fixed light, if possible, and where for distinction a revolving light was necessary, I would confine it to a holophotal light—because, although Fresnel's lights

*Capt. B. J.
Sullivan R.N.*
1 Feb. 1861.

*Capt B. J.
Salomon R.N.*

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are all, to a certain extent, flashing lights, I think it is best to consider them all as revolving lights, merely regulated by the different intervals; and, as a rule, the larger the lens and the fewer the lenses on a circle that you have, where a quick flash is not absolutely necessary, the better.

870. You said just now "fixed if possible," do you consider a fixed light superior to a revolving light?—Excepting in a few particular instances of perhaps great sea lights, where the power of a flash would be valuable, I think as a rule it would be better to have fixed lights only, where distinction was not necessary, as, from the simplicity and the expense, they are decidedly preferable. But there are some few great sea stations, some points that ships make when homeward bound, particularly on our south-west coasts, where, if the most powerful revolving light could be put, without interfering with the character of any lights near it, I should, in those cases, put it in preference to a fixed light.

871. Your objection would depend somewhat on the length of the interval between the flashes, probably?—I think that if you reduced the interval much,—that is, if you multiply the flashes,—you would also reduce the power so generally, that you would lose the advantage, for such stations, of a revolving light. There is no doubt that any one of the large lenses, with 8 on the circle, gives a far more powerful revolving light than what would be considered first-class flashing lights; but in which the amount of light is divided among 16, 24, or 32 lenses.

872. Would not the question of the period of the interval of the light depend very greatly upon the rapidity with which the apparatus turned?—Whatever interval is given to it (I am speaking of the power of the light while it was showing), I believe you lose a good deal of the power when you multiply the circular lenses to give a flashing light.

873. (*Mr. Graves.*) The great inferiority of the Cork light has been very prominently brought before this Commission, and it appears now that you refused to sanction its improvement by substituting a dioptric light. Will you be good enough to state what steps were taken by the Marine Department of the Board of Trade to satisfy themselves of the necessity or otherwise, of that change?—I have not had time to refer to the papers on that question, but the papers will show the correspondence that took place. I have not a doubt myself, judging from what we have done in other cases, that we asked them their reasons for wishing it to be changed, and that they did not satisfy us that it was because the light was a bad one and requiring repair or change, and therefore we refused it.

874. Has the Admiralty forwarded to the Board of Trade any memorial from the Cunard Steam Company relative to the inefficiency of the Cork Light?—I recollect a complaint of the light being made—not of its deficiency, but of the light being neglected in some way. My impression, judging only from recollection, is, that on the occasion referred to it was not any defect in the quality of the light itself, but that there had been neglect.

875. May the Commission infer that no communication was made by the Admiralty to you on the subject?—No; I recollect a communication being made respecting a Cunard steamer, on a certain night, complaining of that light; but I believe that there was nothing in it to show that the light wanted change.

876. In vetoing the recommendation of the Ballast Board on so important a subject, would you not consider it necessary to have personal observations made on the subject, in advising the Board of Trade to refuse its sanction, or would you simply act upon the reasons given for the change?—On the correspondence.

877. (*Mr. Gladstone.*) What are the descriptions of illuminating apparatus which have been recently

put up in the colonial lighthouses under your jurisdiction?—There has not been an but the dioptric light sanctioned for the colonies since I have been at the Board of Trade. There were lights that had been sanctioned and made, before I came to the Board of Trade, that have been sent out since, and which were too far advanced to be stopped; but the only one that was ordered and not too far advanced I stopped.

878. Have you confined yourselves to a fixed dioptric light, and to Mr. Stevenson's holophotal revolving light?—I think most certainly; I am not aware of any other class of light that we have put up ourselves in the colonies.

879. What description of lamp do you employ?—The four wick lamp for the first-class lights with the centre wick removed; but we have adopted, instead of the mechanical principle for feeding it, on the recommendation, I think, of Mr. Wilkins—and I believe it has also been adopted by the Trinity House—the ordinary cistern for feeding the lamp by gravity, which is more simple than the mechanical apparatus.

880. Do you have returns made to you of the quantity of oil which has been burnt?—We have had most perfect returns from the colonies in answer to a form sent to all the colonies, not only as to those lights we have put up, but as to all their own lights, and I believe that those returns have been laid before this Commission.

881. What are the instructions which you give to the keepers about the quantity of oil to be burned?—All the lights that we put up are entirely managed by colonial authorities—we have none of them in our own hands. They have had instructions similar to those of the Trinity House sent out for their guidance, and the management has been entirely left to the colonial authorities. In some few instances, at their request, we have sent them out competent persons from England.

882. As far as you are aware the plan adopted is the same as that of the Trinity House in such matters?—I think so. I should not feel so confident about adopting that mode of feeding the lamp in preference to the mechanical apparatus at home, but I have thought it preferable for sending lights abroad, where there would be more doubt about getting persons to repair them if the lamps got out of order, and where perhaps the lightkeepers would not be so good.

883. You have not effected the same saving of oil as has been effected in the Scotch lighthouses, by lighting and extinguishing the lamp when the sun is a certain distance beneath the horizon?—I supposed that the regulation everywhere was, that the lights were lighted from sunrise to sunset. I can fancy that in the much longer twilights of Scotland, particularly in summer, a great sum might be saved; but in the colonies, particularly those which are more tropical, the change to twilight is so quick that it is not so important.

884. (*Chairman.*) You have spoken of your position as guardian of the pecuniary interests of the merchant shipping trade?—I think the Board of Trade is the guardian of the interests of the shipping by which the light dues are paid.

885. Just so. As guardian of the pecuniary interests of the merchant shipping, and considering the necessity for economy in the application of the Mercantile Marine Fund, do you consider that those interested in the merchant shipping would object for one moment to the expenditure of any reasonable sum of money to secure the best possible light, or that they would not rather object to anything like parsimony or economy, if the principle of economy were carried out so far as to stand between the shipping and their being supplied with the best possible light that science can produce?—I do not suppose that they would ever object to such expenditure as you have mentioned. Neither would the Board of Trade ever object to an expenditure of that kind. The Board of Trade, I

believe, has always acted on this principle—that where the efficiency of important lights was concerned, no money question should be allowed to interfere. I may mention two instances which gave rise to a difference of opinion, before I came to the Board of Trade, with the Scotch Commissioners, as to two lights in Shetland, the Whalsey Skerries and North Unst. In both those cases, although at a considerable additional expense, the Board of Trade agreed with the Trinity House in placing the lights on the most expensive but certainly best stations for the shipping interest, that is, nearer the outer danger, contrary to the recommendation of the Northern Light Commissioners. And I think that shows that where the efficiency of the light and the safety of the trade was concerned, money was not thought of as the most important point. It has been only on points where the efficiency of the light or its value to the trade was not for one moment in question that attempts have been made to cut down the expense. The next matter that I would refer to is the Berehaven buoys. Upon that point Captain Ryder puts this question,—“Then, because men-of-war frequent the harbours on the coast of Ireland, “the merchant shipping is deprived of buoys?” I must say that he quite misunderstood the question if that is his impression. The Admiralty applied for the buoys because large men-of-war were frequenting more than ever, Berehaven; and so much was it a question of men-of-war, and not of the general trade, that one buoy in the harbour was on a 4-fathom patch that nothing but a line of battle ship could touch; and we, as the guardians of the merchant shipping interest, thought, as this was required for the fleet frequenting Berehaven, it was fair, if not all, at least that a great portion of the expense of putting those buoys should be borne by the Admiralty, and not by the Mercantile Marine Fund. And I think that decision was perfectly right. But that because the men-of-war frequented the harbour of Berehaven the merchant shipping were to be deprived of buoys is quite erroneous, and I cannot understand how such an opinion could have been formed; the Admiralty would not provide the expense of the buoys, or a portion of the expense, and the men-of-war have been deprived of the buoys. But the merchant shipping interest, I believe, had never applied for buoys there, and therefore they have not been deprived of them. And when we think that men-of-war have the benefit of all the lights, without paying anything towards them, surely it is not too much to expect that, where buoys are required more especially for men-of-war in one port, that a portion, if not all the expense of those buoys should be borne by the Admiralty. And the principle has been carried out in Portsmouth, where a portion of the expense of the Warner lightship has been borne by the Admiralty, as it is equally valuable to the merchant shipping coming to the Motherbank and to the men-of-war coming to Spithead. In the answer to that question allusion is made to two buoys in the Port of Londonderry, and a complaint is made that we would not sanction those buoys being taken under the Mercantile Marine Fund. I may state, as a rule, that the principle is not to grant the expense of harbour lights and buoys out of the Mercantile Marine Fund. In Ireland, before the Board of Trade had anything to do with it, the Ballast Board had lighted and buoyed a great many harbours, such as would never have been done by the general fund in England or Scotland, and an arrangement was made that those should be maintained, but that no new ones should be put down, except on the principle that they must be in some way more or less beneficial to the passing trade, as well as to the harbour. Whenever the passing trade is so far interested that a place may be used for refuge, we have always consented to a portion of the expense, and in some cases all of it, being borne by the Mercantile Marine Fund; but if we granted all the lights and buoys

required for the small Irish ports out of that fund, we should be doing a great injustice to the general trade, who would have to pay for this. And the same observation applies to several other objections made to our interference, in the evidence of the Ballast Board Commissioners.

886. You have spoken of two buoys in the Port of Londonderry; you do not, I suppose, allude to the Tuns buoy at the entrance to Loch Foyle?—Yes.

887. Do you consider that the Tuns buoy is in the Port of Londonderry?—It is so far in it that it was under their jurisdiction, I think. I now speak from recollection.

888. Are you aware that some time back there was an act of parliament, at least so I have been given to understand, defining the limits of the Port of Londonderry, and that the Tuns buoy, as I can well understand, from its position, was excluded from the port, and considered to be in the open sea, and that therefore they had not a power to levy dues on shipping entering the port to maintain a buoy beyond their jurisdiction. And further, I would ask whether it is not the case that the Tuns shoal is a most dangerous shoal lying in the way of vessels working to the westward, along the north coast of Ireland, especially those seeking shelter, and so working under head, as that shoal lies in their way; and I would also ask, if the Trinity House has a general authority, and can buoy the entrance to the Tees, and support buoys which are purely local, although they cannot be of assistance to the passing trade, how it is that the Tuns buoy, which is now excluded by Act of Parliament from its local place as belonging to the Port of Londonderry, can be otherwise considered as a buoy marking a sea shoal along the coast?—Without a chart before me, I should not like to answer positively some parts of the question; but I am quite sure that we, in deciding as we did, adopted the general rule, and that my conviction was at the time that they could not fairly be considered necessary for the general trade, but were necessary for the trade of the port. Whatever buoys the Trinity House may have, under similar circumstances, certainly if they were to apply to us now for any buoys that were as much necessary for the entrance of a port as I believe these to be, we should not grant them out of the Mercantile Marine Fund. The next point that I have to notice, is the question of the gun in the Kish light vessel, and to that really the same arguments would apply as those which I have used with respect to the buoy. I cannot think a gun in the Kish light vessel necessary for the passing and general trade, and it has only been specially asked for by steamers crossing between Dublin and Holyhead. If a gun is only required for them, on the same principle that it has been generally adopted, they should pay for it, or the Post Office that they have a contract with. In the case of the gun at Holyhead, the Admiralty having jurisdiction in Holyhead Harbour, we considered that they should pay what we thought a fair proportion of the expense for the steamers coming to Holyhead Harbour; but as much as the gun on Holyhead Mountain might be valuable to vessels coming round the Stacks, or coming up or down the channel in a fog, we thought it might be fair to pay half the expense out of the general fund, because the general trade would be partially interested. But, with regard to the Kish light vessel, I cannot see that the gun would assist the general trade at all; and I think it is possible that it might be mistaken by vessels which were out of their reckoning in the Channel coming from the southward, and, if it were so, it would be very dangerous; for instance, if they mistook it for the Holyhead gun. No person having the responsibility there should sanction the gun unless a distinctive signal is made by that gun—I mean distinct from the Holyhead gun; and in giving our sanction to its being put, which we have lately done, provided the expense does not come out of the

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Mercantile Marine Fund, we have made a condition that the gun shall be fired twice at short intervals for each signal, instead of once as at Holyhead, in order to prevent the possibility of a mistake; and if the expense is not borne by the Mercantile Marine Fund, we have not the slightest objection. But that double discharge will make it very expensive. The Holyhead gun, with its single discharge, is a far greater expense than any one would suppose. The powder costs from 150*l.* to 200*l.* annually, which would of course be double for the Kish gun; and that it should be paid out of the general fund, by dues levied on the general trade, which is utterly uninterested in it, would certainly not be fair. And therefore, although we did not oppose the gun being put there if the parties interested, and who want it will pay for it, we do object to its being put there and being paid for out of the general fund.

889. (*Mr. Graves.*) The gun you are referring to was applied for, I believe, two or three years back. Did the application come through the Trinity House to the Board of Trade, or direct from the Ballast Board?—I think that the applications have been principally made from the Dublin Company. Some of them have been made verbally by the chairman of the Dublin Steam Packet Company; but there have been applications through the Ballast Board.

890. Did not the Ballast Board recommend that a gun should be placed there?—I think they did. They certainly have required it, and we objected to it at first on account of the great expense of the gun, the gun being fired twice at every signal, as it must be for safety, and to the expense coming out of the Mercantile Marine Fund. We have recently objected again to the gun being placed there at the expense of the Mercantile Marine Fund.

891. Is it according to the usual course of business that an application of this kind should be received or not direct from the Board of Trade without going through the Trinity House?—I think it has come regularly through the Trinity House. I do not recollect at this moment, for I have not got the papers; but we have had so many personal interviews with Mr. Watson, I think, on the subject, such direct communications, that I do not now recollect everything that has taken place.

892. The reason why I ask you these questions is, that I hold in my hand a letter from the Board of Trade, in which it is stated, as their ground of objection, that the gun on board the Kish light ship might possibly be mistaken for the gun on Holyhead Mountain. Has the opinion of the Trinity House been taken on that particular subject?—Certainly if we were called upon for our opinion we should give it without consulting the Trinity House. If the Trinity House had sent, or whoever may have asked for the opinion, if the opinion had been sent through the Trinity House, and communicated to us by them, we should have conferred with them on the subject.

893. In this letter it is also stated, that steamers crossing the channel could not mistake one gun for the other, but that vessels passing up and down the channel might possibly do so if they were out of their reckoning?—Yes.

894. Does not that lead to the inference that passing vessels would take advantage of it?—No; but that they might mistake it.

895. You are still of opinion that that is a good objection to the gun?—A good objection to the expense being borne by the Mercantile Marine Fund; it is no objection to the gun if the expense is to be borne by others, and a distinctive signal is given; but if you have two distinct guns firing, two signal guns so near to each other, I think they would be as dangerous as having two lights next to each other of the same character.

896. There is a new fog bell being made, is there not, for that ship?—We, from the first, stated that we would sanction an estimate for any more powerful

bell that they wished to have. At that time the Trinity House had adopted the bell of Mr. Wilkins, which was supposed to be much more powerful, and we believed would answer the purpose of this light vessel better, than the gong now there, and therefore we offered to sanction the estimate necessary for such a bell, and to adopt it in preference to the guns, and an arrangement was made with Mr. Wilkins for such a bell; but we have since been informed that further experiments with this bell had rather raised a doubt as to its efficiency in such a position, and while the Trinity House still think it would be useful on shore for the lighthouses, the Ballast Board have thought it necessary to give up the idea of the bell, Mr. Wilkins having requested them to withdraw the contract for it.

897. Then has the cancelling of the contract with Mr. Wilkins for this bell been done at the request of the Ballast Board?—I think so. We were informed by the Ballast Board that Mr. Wilkins had requested them to withdraw the contract for the bell, as he thought it would not answer the purpose.

898. At what distance has he stated in his first estimate that this bell could be heard?—I think three miles.

899. Do you believe such a thing possible?—Yes; certainly, from what we have heard. I believe that the Trinity House are still of opinion that it will answer.

900. (*Mr. Gladstone.*) I see that there are bells at Poolbeg, Bailey, and Kingstown, near the Kish light; do you not think that it might be mistaken for one of them if it rang a bell?—It is impossible that they could be mistaken for this peculiar bell of Mr. Wilkins's, as it was to be struck by a revolving hammer with several blows per second, so as to make a continuous ringing sound instead of the blows of the ordinary bell.

901. You would have an objection to an ordinary bell under the circumstances in the Kish light?—It would of course depend upon what bells were near it, whether it could be mistaken for any other.

902. There appear to be really three others very much nearer than the gun at Holyhead?—This bell could not have been mistaken.

903. (*Mr. Graves.*) You stated that the principal ground of your objection to this gun arose from considering that it should not be maintained out of the Mercantile Marine Fund; do not the steamers that pass from Holyhead to Dublin, carrying Her Majesty's mails, and a very large number of passengers, daily pay toll for the Kish light?—Yes.

904. Is it not therefore reasonable that any expenditure of a moderate kind, which would rather lessen the risk to life and property and the mails, should be borne out of the Mercantile Marine Fund, when those vessels carrying the passengers and mails contribute so large a sum annually for the maintenance of that light?—I cannot alter the opinion that I have given, that the additional cost of a gun placed in that vessel for two special lines of steamers should not be borne by the Mercantile Marine Fund, which is principally supported by the passing trade. I may take an instance with regard to the vessels at the other end of their journey—the Admiralty there pay a portion of the expense of the gun for their coming into Holyhead Harbour,—for that is just on the same principle.

905. Have you any idea of the amount of the light dues that the mail steamers pay annually for the use of the Kish light?—No; I have not. The funds are now all amalgamated, so that it is almost impossible to separate them; we have no means of separating them; without we got a special return from the steam companies we could not ascertain exactly what they paid. I may add that if out of the Mercantile Marine Fund a gun is maintained in the Kish light, I do not see how it could be refused for every light vessel on the coasts of England and Ireland, and which would enormously increase the expense. The next point that I would refer to is to be found in the evidence of the Earl of Meath. He illustrates what

he considers to be the improper refusal of the Board of the Trade to grant money out of the Mercantile Marine Fund, by the case of Copeland Island; and by his evidence it would be supposed that the Ballast Board and the Trinity House agreed that the light-house should be changed from one island to another, and that the whole should be done at the expense of the Mercantile Marine Fund, but that the Board of Trade had refused the money contrary to the opinion both of the Ballast Board and of the Trinity Board. I may say that I entertain great doubts myself if there would be the least advantage in making this change. The light is now on the highest island, and although a low island extends to the eastward of it some little distance, and therefore vessels coming from the eastward would find the light best if on that low island, yet vessels coming from the westward—for instance, from Belfast towards Copeland Island—would certainly then have the light in the worst position for them, and having it now on the island that is nearest to them in their eastern course is, I think, an advantage. Another difficulty would be that the high western island would mask the light in a certain direction; that is, to vessels coming from the westward. Therefore I cannot consider the change desirable even for the trade of Belfast. For the passing trade there is no question whatever that it is utterly unnecessary, and so decided is the opinion of the Trinity House on this point, that while they give their consent to the change proposed, they do it on this condition: In a letter to the Ballast Board, sent in the ordinary course for the information of the Board of Trade, they state that, “having regard to the alteration being for the benefit of the local trade, it appears to this Board that the expense of the change should be met by an increase of toll for the light upon vessels entering or departing from Belfast Lough.” The Trinity House have made their consent conditional on that, and in taking the same view we are only acting in accordance with the expressed condition of the Trinity House. Therefore the statement of Lord Meath is directly contrary to the fact that we have set both their opinions on one side. The next point I would refer to is at Question 258, put to Lord Meath, as to the money expended by the Board of Trade for Irish lighthouses. His answer is, “About 40,000*l.*, including the Calf Rock, the estimates for which have not yet been approved, although recommended by the Ballast Board, amounting to 17,000*l.*” I can only say that such a statement by Lord Meath shows that he can know nothing whatever of the proceedings of his own Board on this subject. The facts are these: On the 18th of March 1858, the plans and estimates were sent to the Board of Trade for their approval, and they were returned with the sanction of the Board of Trade to the plans and estimates on the 27th of March, within nine days of our receiving them, with a request that tenders might immediately be obtained to carry on the work; the dwellings were not included in those estimates and plans, and we suggested that they should be at once proceeded with in order that the works might be combined. No reply was made to that communication for nearly twelve months; that is, from the 27th of March 1858 to the 10th of March 1859. On the 23d of March we pointed out to them that the plans for the dwellings required reduction. That is alluded to in another place as a proof of how we unnecessarily curtailed their desire to improve the dwellings of their lightkeepers. The reduction was made on this ground. They proposed to have six good rooms for each keeper’s dwelling—four being the outside number which had been given up to that time I believe in any dwelling in England or Scotland, and I believe in Ireland—and they stated their reason to be, not the accommodation of the families, as Lord Meath states here, but that “extra accommodation might be provided for shipwrecked mariners if thrown on those shores.” On the 22d of March we wrote to them requiring them to reduce their plans to four rooms

each, the regular allowance that was made either in Ireland or in Scotland, and we showed them that the four rooms gave as large an amount of accommodation as had ever been allowed to lighthouse keepers. I may here remark that these are the very dwellings that Mr. Stevenson calls in question in the comparison made with the Scotch dwellings as to the comparative estimates, and he states that the accommodation was so much less and that my statement before the Committee of the House of Commons was wrong. Before referring this back to the Ballast Board I compared the amount of accommodation in Ireland with the amount of accommodation in Mr. Stevenson’s dwellings, and I was quite satisfied that there was the full amount of 400 square feet of area in each dwelling as was given in the Scotch dwellings, and it was on that ground that we refused them the extra two rooms. Therefore I can positively say that the accommodation in those dwellings was quite as great when they were reduced, and when their estimates were afterwards changed, as in any of the houses provided by the Scotch Commissioners, and therefore the comparison is a fair one, and not as Mr. Stevenson said, made erroneously. The Ballast Board Commissioners reduced their estimates from 2,000*l.* for the four dwellings, which were equal to six dwellings, to 1,500*l.* for the four dwellings when they were reduced to the same size as the Scotch dwellings, or 400*l.* per dwelling, a little more than half the amount of Mr. Stevenson’s estimates for similar dwellings. The reduced estimates were sanctioned by us in May 1859, two months only after first receiving those estimates, and from May 1859 as to the dwellings and from March 1858 as to the buildings nothing was sent to us in the shape of tenders, nor was our consent asked to sanction any tenders for proceeding with this work until the 22nd of November 1860, more than two years having been taken up by the Ballast Board, or by their engineer, Mr. Halpin, in carrying out what we had sanctioned. On the 27th November we referred them back for more information, and we received that information, and sanctioned their acceptance of tenders on the 10th December, so that the delay in carrying out the work rested entirely with the Ballast Board, as their tenders were not sent to us for approval till two years and a half after we had sanctioned the plans and estimates. I think it will be seen that this bears out what I have stated before—that Lord Meath could not have understood what had been done at his own Board on the subject. A question was put by one of the commissioners (question 254) to Lord Meath—“Had there been a local trade there it would have been benefited by that beacon. Do you think, judging from your experience as to other applications, that the Board of Trade would have consented to placing beacons there?” By that it is inferred that if the local trade would be benefited as well as the passing trade, it would stop our granting any outlay from the Mercantile Marine Fund. That is totally erroneous—such an idea has never been expressed in any communication that we have had with the Ballast Board. If the local trade alone was interested, we should not sanction the outlay. But however largely the local trade might be interested, if the passing trade would be interested in being able, by these beacons, to use the place as a port of refuge, the application would have been granted as it was in this case. At question 259 a similar opinion is expressed—“Are the commissioners to understand that the Board of Trade, as a general rule, have no objection to marking or buoying bays which may be considered, or which may serve as harbours of refuge, provided there is no port inside them, but that they refuse always to light those harbours?” That is also quite an erroneous impression, and I need, I think, only instance the case of Galway. Although there is a harbour inside of Galway Bay, two new lights, at a great expense, have been sanctioned by the Board of Trade for better lighting the

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entrance to Galway Bay, which is in itself a large port of refuge. They have been sanctioned and built. They are on the Arran Islands, at the entrance of the bay, and it is only a second harbour light in Galway Harbour itself that has been refused on the principle that it was purely a local light for a local harbour. The whole of the entrance to that bay and harbour has been lighted at the expense of the Mercantile Marine Fund, out of which fund the harbour light on Mutton Island is also maintained; but an additional local light in the harbour inside, not required for making the bay or for the purposes of refuge in the bay, should not come out of that fund.

906. (*Mr. Graves.*) Are not the lights in the entrance to the bay used, to a very large extent, as coast lights?—The passing trade round there is very small. For the coast trade only passing, the one light on Arran Island, as before, would have answered every purpose; but it was thought for that trade safely entering Galway Bay for refuge, or for the trade of Galway Bay entering it safely, that the two lights, one at each passage, were much safer than one large central light, and they were unhesitatingly sanctioned by the Board of Trade, at the expense of the Mercantile Marine Fund, and were just completed when I came to the Board of Trade, I think in 1856. It was before my time.

907. Is it not notorious that vessels seeking shelter run up till they anchor in the roads close to Mutton Island in Galway Bay?—One favourite place of shelter is, I think, under the Arran Islands—they anchor under the Arran Islands. But the light that was asked for at Black Rock was entirely asked for, I believe, for the new Galway steamers; and certainly the Southampton Dock people might just as well expect the Mercantile Marine Fund to light the entrance to their docks, as at Galway Harbour for the mail steamers to expect that the Mercantile Marine Fund should place another light for their use.

908. Did not the Commissioners of Galway Harbour express their willingness to allow a toll to be collected for that light, if it were erected out of the Mercantile Marine Fund?—I do not recollect at this moment.

909. Did the Ballast Board recommend that a light should be placed there to be maintained out of the Mercantile Marine Fund?—I think they did. I cannot speak positively about it, but the principle, I am convinced, was perfectly right, not to sanction that light out of the Mercantile Marine Fund—that is, supposing that the principle on which we have generally acted in sanctioning expense out of that fund is a right one; because we cannot make a difference between one place and another. Question 284 refers to keepers for rock stations: "How many keepers are there at the rock stations?—We have just succeeded in getting permission from the Board of Trade "to have a third man always present at a rock station "where the families are not able to be accommodated; "the only exception is the Black Rock in the entrance "to Sligo, the reason being that it was too near the "main land." It appears to be inferred that there has been a difficulty in getting that from us. I may say, as a rule, that we have always sanctioned three or four men for rock stations, and I am not aware that it has ever been objected to for a moment; where families could not reside with them—there has never been a difference of opinion, that I am aware of, on the subject.

The evidence goes on in this way: "How long were you in obtaining that permission?—I think we "have been applying for it for three years."

That is an extraordinary thing. I do not recollect any question arising between us unless it has been a question where a family has resided on a rock or an island, and to a lighthouse in that case, as a rule, we should not sanction three keepers; because there is not a case, I believe, under the Trinity House in which there are more than two keepers where the families reside on the spot; but if they are cut off from

the dwellings by sea, I have no hesitation in saying, that we should not think of refusing an additional keeper. I have not had time to look into this case, but I do not recollect ever having refused a keeper to a light for three years. I have nothing more to say, I think, upon the evidence given by the members of the Ballast Board.

910. In July 1859, the Irish Board proposed certain buoys for Lough Swilly?—They did.

911. In August 1859, that proposition received the sanction of the Board of Trade, except as regards colours?—It did.

912. The Board of Trade, it appears, suggested that one buoy should be checked on each side?—That I do not recollect.

913. Did the Ballast Board propose any particular mode of colouring those buoys?—I think they recommended that they should be red on one side and black on the other.

914. Did the Board of Trade make any alteration in the recommendation of the Ballast Board?—The Board of Trade suggested that two dark colours should not be used to mark the two sides of a channel, but that there should be on one a dark colour, and a parti colour on the other, such as black, and black and white, or red and red and white, which would better mark the sides of the Channel.

915. Under what clause in the Merchant Shipping Act has the Board of Trade power to originate or require the colour of the buoys to be changed from the recommendation of one of the governing bodies? The alteration was a suggestion from us for their consideration—not exercising any power to make them alter it, but a suggestion from us for their consideration—whether this particular class of colours for buoys would not be better than two dark ones. That suggestion was agreed to, I believe, both by the Ballast Board and the Trinity House; but I believe, had we desired to exercise an authority, we had perfect power to do so under the Merchant Shipping Act, in one way by refusing to sanction the outlay necessary for those buoys if our views had not been adopted; and we might, although we have never exercised such power, have gone still further, and directed what should be done in placing those buoys, and they must have followed our directions.

916. (*Chairman.*) But although you say you have never exercised that power—namely, the power of directing what should be done; yet you do conceive that the Merchant Shipping Act gives you that power?—Certainly; by the 406th section of the Merchant Shipping Act, it is stated—"In order to "obtain such sanction as aforesaid, the Trinity "House shall forward a copy of their notification, "accompanied by copies of all communications that "have passed between the Trinity House, and the "said commissioners or corporation to the Board of "Trade; and such Board shall have power to give "any directions they may think fit in relation to the "matters submitted to them by granting or withholding their sanction, either wholly or partially, "and either with or without modification." The 407th section then goes on—"The Trinity House "shall forthwith communicate the directions given "by the Board of Trade, in relation to the matters "aforesaid to the said commissioners or corporation "and the said commissioners or corporation shall, "upon the receipt of such directions, be bound to "act in conformity therewith, and to do or forbear "doing anything thereby directed to be done or forbore." That power has never once been exercised under those two clauses by the Board of Trade. I have before said that on these points the President would have the legal advice of the Secretary and Assistant Secretary; and I should not venture to speak decidedly on the subject did I not know their opinions.

917. Then you consider that the Merchant Shipping Act virtually puts an end to all independent

authority on the part of the three general lighthouse boards?—Independent authority certainly; so far that they have no power to act independently of the Board of Trade in placing any new light, buoy, or beacon, or in doing anything, or in altering any lighthouse, buoy, or beacon, that requires an additional outlay. That must be applied for to the Board of Trade.

918. Then their functions resolve themselves simply into that of being officers of the Board of Trade?—No; I think not, because they originate all new works; but let me say that this applies entirely to the two Boards and not to the Trinity House; the two Boards having communicated through the Trinity House. We have power to give instructions to the Trinity House with reference to the applications of those two Boards. Those two Boards are certainly not independent authorities so far as exercising any independent power goes, for they are subject not only to the objection of the Trinity House, but also of the Board of Trade; but the Board of Trade has power to decide between those two Boards if they should differ on any point.

919. Then would it not simplify matters if the Scotch and Irish Boards were made de facto part of the establishment of the Board of Trade, because, although you have said that they may originate matters yet that may be said of the officers of every department; you may require this or that officer to originate a scheme because it is his duty to do so; but if you are at the Board of Trade to be the overruling power, it comes to the same thing, whether it be originated in your own office, by your own officers, or nominally in another office by persons supposed to be distinct authorities?—The Northern Light Commissioners have, or the Ballast Board have, certainly hitherto always so far acted independently that they have never been by any authority of the Board of Trade compelled to do anything that they objected to do; so far the power has never been exercised.

920. Would you say that that applies to the action taken in the case of the light at Rhu Vaal?—The character of the light at Rhu Vaal was altered certainly, but by the opinion of the Trinity House and the Board of Trade conjointly on a purely nautical question, which nautical question there is really no person competent to give an opinion upon in the Scotch Board.

921. But I think an opinion was given on the subject by the surveying officer on the station?—There was; but I am quite convinced that he was wrong, and the Trinity Brethren who were there and myself quite concurred on the point that the Scotch proposition was entirely wrong. There was some little difference at first between us as to which would be the best plan. I differed in one respect from the Trinity House, but I eventually agreed with their opinion, and I am quite convinced that no persons having the responsibility of fixing the character of that light could, doing their duty and understanding nautical matters, have left the light in the way it was proposed to be left by the Northern Light Commissioners. The facts are these: a channel seven or eight miles distant from that light has dangerous rocks in it, and the question is, should that light be made use of to warn vessels from running into that danger or to guard them through it, or, on the other hand, should it be left dark, and should vessels be allowed to run on these rocks within the range of the light which they are denied the use of. I was perfectly astonished to find that any proposal of the kind could be made, and more particularly by a nautical man. I think I can illustrate the point very clearly by taking the case of the Scilly Islands. For many years the St. Agnes light was the only Scilly Island light, and vessels bound up channel, making Scilly, had a dangerous reef of rocks to avoid, six or seven miles seaward of St. Agnes light, on certain bearings, and, according to the Scotch Commis-

sioners view of the case in that dangerous direction the St. Agnes light should have been darkened, and should only have shown a light in the direction that a vessel could have approached it safely. Now, would any one for one moment have taken the responsibility of darkening the St. Agnes light over the Bishops and Western rocks of Scilly, or would they not have said it is important to have a light showing as far as possible over those rocks, in order that by its bearing a vessel might know her danger and haul out in time to avoid those rocks. Now, on that hinges the whole question. I am convinced that no sailor, who really understood the question, would say that dangers seven miles from the light in the exact direction that vessels are likely to approach it, are better left dark than that a bright light should be used, if possible, to guard them from the dangers.

922. Was not it a question of the colour of that light?—The first question is, a light at all, or darkness. The next question is, supposing it was allowed that the Scilly light should warn vessels from those western rocks, seven miles off, should that be done by colouring the light over those rocks that would reduce its extent of range one third, or should it be made to show as far as possible over those rocks. I have no hesitation in saying, that 99 seamen out of 100 would say, let us see the brightest light as far as possible over those rocks, instead of a red one, as the rocks might be sometimes guarded at a distance of a mile or two beyond them by a bright light. If that light was a red one it might only show to a mile or two inside them, and so vessels might get on the rocks for want of seeing the red light when a bright light would have saved them. Then there is a third question. Suppose a passage for a ship through those rocks, would you use that light, not only for a warning light, in order to clear them, but would you endeavour to use it, so that if a vessel could not haul up in time to avoid them it should enable her to take a safe passage through them? Now, in this case, the passage through them was two or three miles in width, and if a red light had been shown alone it would have often left the rocks outside the light, when a bright light might have enabled a vessel to haul up and weather Oronsay. But my own view was, that while the danger should have been guarded against with a bright light—that is, that a bright light should be shown over the dangerous lines of approach—the clear central channel should be left with a red light, because while a vessel was in darkness outside the red light she would be in perfect safety; if she saw the red light she would be in perfect safety. But the danger would be guarded by the most powerful light, and she would soonest, in thick weather, see the light that would save her. If you adopted the red light as the danger light you would, in the case of a distant danger, often throw the bright light in the clear channel, where it would be less important, and leave the danger unguarded by the red light. Whereas, if you guard the danger by a bright light, you ensure, at all times, the greatest protection in the direction of the danger. If the red light was obscured at a certain distance, a vessel in darkness would be in safety, and if in danger would have the most powerful light to guard that danger. If the danger is quite close to the light, so that the comparative range of the red and the white lights is unimportant, it may be a question whether to make the red a danger light; but certainly it would increase the danger where that danger lies at a distance of some miles from the light. We have instances, I think, of the red light marking the clear channel; on the Irish coast there is one leading inside the Cope land Islands. Harbour lights are often red, and if a principle is to be laid down not to be departed from, then I would certainly adopt a bright light for a

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danger light, and a red light for a safety light; because, while one might lead a vessel astray dangerously, the other could not; and, therefore, as there was a good light near this channel, although I would have warned vessels against using that channel, had I had the sole responsibility of lighting the channel, I would have placed a bright light there only over the dangerous rocks, and then have had a red band of light in the clear channel.

923. Have you not, in point of fact, assumed that very responsibility, in having the light according to your own wish in this respect, different from that which was proposed by the Scotch Commissioners?—No; certainly not. The Board of Trade have sanctioned the plan proposed by the Trinity House, which Board therefore shares the responsibility, and which is a plan that makes the light a warning light, but which does not act as a leading light through danger, if necessary.

924. Still the fact remains the same; although, as you have stated, you have not overruled these two Boards, yet, in this case, there would seem to have been an exception?—In this case, with the consent of the Trinity House, or in supporting the view of the Trinity House, we certainly have overruled them in the character of this light. I may also say that before I came to the Board of Trade, in the same way with the Trinity House, the Board of Trade had overruled the Scotch Commissioners on the position of those two lights in Sledland that I previously alluded to. But, by saying that we had not overruled those Boards, I meant that we had not exercised that authority, under the 406th and 407th clauses, which I think we had power to do—to make them do a thing which the Trinity House and the other Board conjointly had differed from the Board of Trade upon.

925. You think that you were still acting within your authority when the Board of Trade overruled the Commissioners for Northern Lighthouses in the selection of the illuminating apparatus to be used at the Butt of Lewis?—That was again a question of the character of the light, and I have not the slightest doubt that the Trinity House and the Board of Trade have adopted the right distinction. To show this, I will state, as a rule, that it would be desirable to have revolving lights and fixed lights alternately on the coast; and as Cape Wrath, the next great sea light, is a revolving light, the Butt of Lewis, under ordinary circumstances, should be a fixed light, particularly as there is no outlying danger, and as it is a light that vessels can boldly run for; therefore there is another reason why it should be a fixed light. When I first thought that the Butt of Lewis should be a fixed light the Monach lighthouse was not yet decided upon. I had already marked a position somewhere on that west coast for one more light, when asked by the President of the Board of Trade what more would be wanted to complete the lighting of the coast. Therefore I knew that a light, that ought to be a revolving light or flashing light, would come somewhere midway on that western coast, which was another reason why the Butt of Lewis should be a fixed light. Another reason was, that the light that would come next again to the Monach light, although an intermittent light, is so likely to be mistaken for a fixed light, but never can be mistaken for a revolving light. If a fixed light had been placed on the Monach group we might have had two lights near each other that might be mistaken. When a man sees a light for two minutes and a half not varying he may not take the trouble to look for the short interval when it is darkened, but he may have satisfied himself that it was a fixed light. He could not mistake a quick revolving light for Barra Head, but he might mistake Barra Head for a fixed light. The correspondence will show that that opinion was expressed to the Trinity House before they had decided on the character of those lights, and they immediately acquiesced in that

view. They agreed with us that a revolving light for Monach, and a fixed light for the Butt of Lewis, were the best.

926. When you state that it would only be over the Northern Commissioners and the Ballast Board that you would be likely to exercise the absolute authority given to you under the 406th and 407th sections of the Merchant Shipping Act, yet some such authority seems to have been practically exercised in the case of Godrevy, because the Trinity House had selected a site originally, and that was not the one finally adopted by the Board of Trade?—I can assure the Commission that this is quite a mistake. It is true that eventually there was a difference of opinion between the Trinity House and the Board of Trade, and the Board of Trade exercised an authority under the power given to them, of not granting the money for what was required, for a more expensive site. So far as we have a control over the money, we have a certain power; but so far was it in reality from that site having been selected by the Board of Trade contrary to the opinion of the Trinity House, that the papers published on the subject will show a totally different state of things. The facts are these: the Trinity House, in January 1855, forward a number of memorials for the light in question to the Board of Trade, and they state that they will give their opinion upon it when the committee has examined the site. The memorials consist of eight from all the different ports in the west of Cornwall, where the trade is interested in this light, and, without exception, those memorials ask for the light on Godrevy Island, where it now stands, or one in a still worse position, on the mainland, and not one of them asks for a light on the Stones. The Trinity House having sent their Committee to examine into the question forward to the Board of Trade the report of that Committee in July 1855. That Committee having discussed the question of the site, both on Godrevy and on the Stones, come to this conclusion: "That the erection of a lighthouse on the former (the 'Stones') would be an undertaking which, even if practicable, would require a larger outlay of money than would be considered compatible with the object in view, and they are of opinion also that the site on Godrevy Island will indicate the immediate vicinity of the 'Stones,' with sufficient precision to warn vessels approaching the coast off the danger. In that position it will also be most valuable to vessels steering along the coast, and particularly to those bound into or coming out from St. Ives or Hayle, as a leading mark through the safe channel between Godrevy Island, and the southernmost 'Stone.'" They also state—"Under all the circumstances, therefore, the Committee resolved unanimously to recommend the Court to adopt the site on Godrevy Island as the most suitable for a lighthouse. They are of opinion that a tower of moderate elevation will be sufficient, and they trust that the facilities afforded at St. Ives, or Hayle, for carrying on the work will enable the Corporation to accomplish it at a reasonable outlay, and within a short period of time." Now, nothing can be plainer than that, after considering the whole question, the Trinity House came to the conclusion, and recommended to the Board of Trade, that the light should be put on Godrevy Island as the best of the two positions asked for by all the memorials; and if the Board of Trade had, without any further discussion, approved of that suggestion,—which I allow I should have recommended to have been done,—then the light would have been exactly where it is, on the recommendation and responsibility of the Trinity House alone, sanctioned by the Board, and no question of error as to that position would ever have been raised. But, before sanctioning that, Admiral Beechey raised a question, by a minute of his, as to a further consideration of the practicability of putting it on the Stones if possible before sanctioning what might be an inferior position, and the

question was referred to the surveying officer of the neighbourhood. That led to more investigation, and the result was, that it was ascertained that if the light could be erected there (for there was some doubt even to the last whether it would be practicable), it would be done at a cost of something like 50,000*l.*, instead of about 8,000*l.* in the other. The result of that was, that the Board of Trade decided to adhere to the first recommendation of the Trinity House. In that decision, I confess, after visiting the spot and going carefully through all the opinions, I quite concurred, and I will go still further, and say, that even if there had not been that difference of expense, or any doubt about the practicability of it, for the sake of opening the small channel inside the Stones, I would have preferred putting the light in the present position. I have consulted several masters of coasters—I think three on one occasion in St. Ives and Hayle—and they all three of them told me that for their coasting trade, and for steamers, which always use that channel, a light is much better on Godrevy, to enable them to use that channel at night than if put on the Stones. I can quite understand that, and I believe that for over-sea vessels the light is quite near enough the danger, and for the advantage of keeping that channel open for the coasting vessels by night, I should have decided the disputed point as it has been decided, under any circumstances. We have heard of no accidents of any kind since the light has been erected on Godrevy.

927. You will conclude, I imagine, that my reason for putting the question was as a sequence to the answer given to the Question 429, by the deputy master of the Trinity House?—Yes; but I think it is impossible that any one can dispute this fact, that if the Board of Trade had not existed as a controlling authority over the Trinity House, and they had been left entirely to the memorials and their own decision, the light would have been in the very same spot as it is now. I may add, that the difference of opinion which arose with Admiral Beechey and the Trinity House was as to whether the light might not have been put on St. Ives's Point, and made a leading light past the Stones. The Trinity House objected, and Admiral Beechey at last coincided with them. I think that in that case the Trinity House were right, for I would much prefer putting the lighthouse where it is; but at the same time, as there was a doubt about the site, it was a question that should have been opened and discussed.

928. With reference to what has just passed, I would ask you whether you are aware that the Board of Trade, as exercising that authority which you have just spoken of, have any fixed principle or rule as to the placing a light, if it be possible, on the most extreme point of danger to be guarded?—Most certainly, as a rule, they would prefer, as they have in two cases in Scotland, to put a light as near the danger as possible. Had the Stones been a continuous reef extending from Godrevy Island, I should have recommended, if practicable, regardless of expense, that a light should have been put on the Stones; but that case is entirely altered when the navigable channel used in preference by the coasters exists so close to the light that they can now pass it quite close, and be sure that they are inside of the dangerous rocks. I will now proceed with my general remarks. In answer to Question 404, "Is it the case that the Board of Trade requires the Trinity House to furnish them with the specifications, in all instances, for illuminating apparatus?"—The deputy master of the Trinity House says "Yes." This is a mistake on the part of Admiral Gordon. The plans and estimates were sent for our approval, but I am not aware of our ever having asked the Trinity House to send us their specifications before we ap-

proved. We have on two or three occasions, when we have been engaged in colonial lighthouses, asked them to send us their specifications for our assistance in framing specifications for colonial lighthouses. Admiral Gordon says, in answer to 410, that he thinks the general estimates for the year should be submitted only to the Board of Trade, and not the special estimates for the different outlays. Now, supposing that the Board of Trade is to exercise the control given to it by the Act of Parliament, it would be impossible to take the whole of the estimates and to inquire into every case mentioned in those estimates, to enable us to get the information necessary, with plans and estimates for them all, and to enable us to give an opinion on the whole estimates at once for the year. We give a general approval of the estimates, which are rough estimates before the plans and specifications have been made out, with the understanding that each specific work is to have its plans and estimates sanctioned by us when the case arises. It would be impossible to exercise any control over them, or to offer any opinion upon them, if any other plan was adopted. At Question 436 I find this: "As the matter now stands, was the action of the Board of Trade, in suggesting the particular application of the light, in your opinion within the meaning of the Merchant Shipping Act?—I doubt whether it was strictly in accordance with the spirit of the Act." I may say that since I have been at the Board of Trade I have endeavoured as much as possible to settle those points that we each have to give an opinion upon without correspondence, and to endeavour by meeting on the spot to settle everything by discussion on the spot before a formal proposal is made; and I am quite sure that we have reduced the correspondence, and the difficulty also of agreeing, very much by doing so; and therefore many of the things, particularly relating to Scotch lights, that have been decided upon, have been decided in the first place by discussion between the parties. I have on two occasions accompanied the Trinity Board to meet the Scotch Commissioners, or Mr. Stevenson, to settle these points, and on both occasions we have settled the points that had previously given rise to correspondence, and would have given rise to much more correspondence; we have settled them in one day without any difficulty. Although this may not be strictly in accordance with the Merchant Shipping Act, what we agreed to has afterwards been sent in the usual form, through the different Boards. But I believe that had we chosen to direct that alteration in the light it would have been in strict accordance with the spirit of the Statute; but in this case, as we were acting in conjunction with the Trinity House, I cannot see how Admiral Gordon should think that we were going beyond the spirit or even the letter of the Act. There is one point in Admiral Gordon's evidence that I wish particularly to explain. In one answer he speaks of my having gone with the Trinity House Committee in their steamer, as if it was not their wish that I should go, but that they did not like to refuse the request of the Board of Trade that I should go with them. I was very sorry to see that, because the first time that I accompanied them, I did so at the request of Captain Shepherd, the then Deputy Master, and he certainly agreed with me that it would be desirable that we should go down and see those things on the spot, with the Northern Light Commissioners, and so, if possible, settle them. He certainly expressed his wish that I should accompany them, and had I not supposed that on every occasion I have been with them I had gone with that understanding, or had I supposed for a moment I was considered to be only tolerated on board because the Board of Trade had requested it, I certainly should not have accompanied them.—Referring to the 464th question, this is what is said: "Adverting to the question put at your last examination relative to the light at Rhu Vaal, and to

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"the interpretation which would appear to have been put on clause 422 of the Merchant Shipping Act, as to the controlling power of the Board of Trade in that instance, and seeing that in case of a difference of opinion between the Scotch Board and the Trinity Board the Act makes the Board of Trade the ultimate referee, are you of opinion that inconvenience to the public service might arise from the power given to the Board of Trade by that Act being so interpreted?—Yes; it is not desirable that the Board of Trade, who are the ultimate referees, should interfere until appealed to; but courtesy to the naval adviser of the Board of Trade has induced the Trinity House not to decline being accompanied by him whilst employed in preliminary inspections." The next point is the Iron Rock. Question 467 is put to Admiral Gordon as to the site of the Iron Rock for a lighthouse, and the expense of that lighthouse, which led to its being refused by the Board of Trade. If the Commissioners will refer to the previous correspondence on that subject, they will find that Captain Bedford had recommended Dunan's Head, abreast of the rock, as the site; that Mr. Stevenson had recommended a site somewhere on the main, on account of the expense of putting it on the Iron Rock, and that while Goat Island would be the best for leading to the small anchorage, Dunan's Head would be the best position for lighting vessels in safety past the Iron Rock, and therefore agreeing with Captain Bedford. After that, the representatives of the three Boards met on the spot, and without any reference to the cost of the thing, or to the trade for which it would be erected, it was decided that the best site would be the Iron Rock, and no one can doubt that if no other thing was considered, the Iron Rock would be the best site; but when the Northern Light Commissioners sent the plans and estimates for it to the Board of Trade, we found that it would cost nearly 10,000*l.*; above 6,000*l.* for the light, and 3,400*l.* for the three keepers dwellings on shore, together with the necessary storehouse and road and enclosure that would have to be made. It was then certainly the duty of the Board of Trade to consider, whether such an outlay from the Mercantile Marine Fund would be justifiable for the amount of trade using that channel, and it was ascertained that, even if charged for a rock station, the tolls that could be levied for the light would only amount to 75*l.* a year, and therefore the remaining cost,—besides the first heavy cost—of 300*l.* or 400*l.* a year at least, must have been a permanent charge on the shipping of the United Kingdom, to enable the small trade of that channel to have this light on the Iron Rock. The decision came to was, that unless it could be put there for very much less, something like 6,000*l.* or 7,000*l.*, we should not feel justified in granting the money for it. That question also raises the point of the cost of these dwellings; the estimate for three keepers dwellings of four rooms each was, as I said before, with the necessary outworks, 3,400*l.*; but if we separate the bare dwellings from the rest, I think it would amount to something over 2,000*l.* Now, the accommodation given by Mr. Stevenson's buildings for keepers, compared with their cost is, in my opinion, after having carefully considered the whole matter for a long time, not in proportion to what it is in England or Ireland; and although Mr. Stevenson disputes the point with regard to a comparison with one of the worst rock stations in Ireland, which we happened to have before us at the same time, I repeat that the actual comparison is this,—that for dwellings of the same size, with just as much accommodation in Ireland as they proposed to give in Scotland, while Mr. Stevenson's estimates exceeded, I think, 2,000*l.* for three dwellings, the Ballast Board's estimates were 1,500*l.* for four dwellings. The question had arisen before with regard to several

other lighthouses, and when I first went down, I was surprised to see at Rhu Vaal the most expensive style of dwelling that it is possible to conceive; that is, dwellings on one floor, of course entailing double the foundation and double the roof for the same amount of accommodation. Except it were in a very exposed position, I do not think that we should be warranted in sanctioning such an outlay, because it has not been found necessary in England. On the most exposed positions, such as the Land's End or Lizard Point, the Trinity House has always put double dwellings of two stories, and I believe, every other thing being equal, that the difference would amount to something like 30 per cent. By personally, in the first instance, explaining to Mr. Stevenson, and afterwards in writing, they were told that we should not again, except in special cases, sanction the cost of putting the dwellings on one floor, and that they should be put on two floors. It was done in two out of the three next lighthouses sanctioned; but we were asked to sanction a single storey dwelling at Pladda, as it might require the light to show over it, and that was immediately sanctioned; the Board of Trade therefore first reduced the expense by making them build on two stories. I mention this case because in a letter written to this Board, I believe by the Northern Light Commissioners, they have stated that they have brought the expense down as low as possible; but, in fact, what they have brought it down to was done by the Board of Trade, and not by them, because the Board of Trade said, you must build them on two stories; and also said, you must have no ornamental cut stone or cornices in the rooms, which I see Mr. Stevenson allows, in his evidence, amounts to 180*l.* for one small dwelling. It is by these means, our objecting to the items, that the expenditure has been reduced to what it is; but after all that, we find the amount comes to about 700*l.* a dwelling, for the three keepers dwellings on the island of Jura, for the Iron Rock Lights. I do not think that the Board of Trade would be justified in sanctioning such large estimates for dwellings, unless they are perfectly satisfied that dwellings perfectly good and strong in every respect could not be built for a lower sum. I have no doubt whatever in my own mind, that these Scotch dwellings cost a very unnecessary sum, comparing them with the English and Irish dwellings. I can come to no other conclusion, notwithstanding what Mr. Stevenson has said. And I have another means of comparison. The coast-guard authorities have lately been building new coast-guard cottages round the coast of England, and I have had their plans and specifications sent to me. I could not find the large drawings to bring with me, but this little sketch (*exhibiting the same*) will give an idea of them; and there is, as nearly as possible, the same area in the ground floor, and they give nearly the same amount of accommodation as the Scotch and English dwellings; but they are divided differently, for instead of two rooms of 12 feet, giving an area of 12 feet by 24, which is about the size of the Scotch, where they have a staircase outside, they give one larger room, and divide the bedrooms into three instead of two, which I think is a better arrangement. Those dwellings appear all to be constructed of the best material, quite good enough for any class of man that a light-keeper can possibly be. As far as durability goes, they have been constructed without regard to expense on that point, and they have been built as solid and good dwellings for the coast guard; and I think we may fairly compare those with what, in similar situations, a lighthouse dwelling should cost.

929. You are speaking of the dwelling houses in connexion with the lighthouse on the Island of Jura, but in general I should think they would hardly admit of a comparison with the dwellings for the coast guard, as you would naturally select a sheltered place for them on a wild coast, whereas for a light-

house you must take the most exposed place on that coast?—The coast guard are as close to the coast as the lighthouses, and the being a little more or less exposed would not affect the price, if the distance from labour and material is not greater, and the facility of obtaining materials the same.

930. (*Mr. Graves.*) Are these buildings built of brick or stone?—They are of brick in some places, and stone in others.

931. Would you sanction the construction of dwelling houses in Scotland of brick?—They use it by preference.

932. (*Chairman.*) Is it solely on account of the cost of the dwellings, and not of the lighthouse, that the Board of Trade has declined to go on with the lighthouse on the Iron Rock?—Certainly not. The cost of the lighthouse is the principal reason. The cost of these coast-guard cottages per pair in the different localities varies from about 350*l.* a pair to 700*l.* or 750*l.*; the latter, I think in one case only, where the material has to be drawn seven miles; the average is about 500*l.* a pair for dwellings, as to which I have had the opinion of the engineer officer attached to the Board of Trade, Captain Galton, and which opinion is, that although not as expensive in many cases as the Scotch specifications, they are quite enough for any class of men of that kind. He winds up his opinion, having compared the plans and specifications of the two, in these words:—"There can be no doubt that the cottages proposed for the coast guard are amply adequate for the class of men who inhabit them, and, consequently, any expenditure incurred to obtain more expensive dwellings is a waste of money."

933. Is it not the case that you have approved of the plans sent in by the Scotch Board?—The plans and estimates came together.

934. Have you approved of the plans?—We have not approved of the plan for the lighthouse on the Iron Rock, but it is not that which gave rise to it; we have approved of similar plans for dwellings in other places.

935. Who is to prepare the plans if the Scottish Commissioners are not to prepare them?—There has been no question as to whether they are to make them or not. We have suggested an alteration in the plans to this extent—after I saw Rhin Vaal,—at the same time we suggested that the dwellings should be of two storeys; we also suggested that the light-keepers should have not less than four rooms instead of three rooms.

936. I am speaking of the plan of the lighthouse which you say you did not approve?—The only objection to the plan of the lighthouse on the Iron Rock is its cost; we think that it is out of proportion to the wants of the trade in that place.

937. Are you of opinion that there is any one more capable of forming a just estimate for such a work, when the plans have been approved, than the engineer employed by the Commissioners of Northern Lights, or that there is any set of men more capable of judging of the reasonableness of that estimate than the Scotch Commissioners themselves?—I believe that, although the plans may be very good, they may be carried out in an expensive way, and that the Scotch dwellings have cost more than dwellings for those keepers need have cost. I have formed that opinion after making all the inquiries that I can, and seeing the dwellings myself; and I may instance this: I made one inquiry through a friend at Oban. I saw some very good houses that were built for gentlemen there—one for the surveying commander at Oban, and I thought I should like to know the cost of such houses. I wrote to him, and sent him an exact sketch of one of the double storied houses in question. I asked him to inquire of the builder who built his house what a gentleman could get such a cottage built for at Oban, of the very best material and workmanship, well finished, enough for a gentleman's small house, to be thoroughly strong, and to be

a good winter residence in that climate if necessary; and the answer was to this effect, that they had only one builder at Oban, and, therefore, he was an expensive one, although a very good one, and he said that he could not build such a house at Oban under 400*l.*; or, if cut stone were used for corner stones, which would have to be brought from Glasgow, 460*l.* This would have been an exactly similar dwelling to the one at Corran Point, for which I think the estimate was 1,400*l.*

938. But Oban is a town, the workmen and materials being all convenient, and Corran Point is in an exposed situation where there would be great difficulty in getting either the one or the other?—I mention Corran Point because it has not the objection of being an outlying island, for there is a village for workmen to live in, close to it, and it is not much more isolated than Oban. I would take Holborn Head as an instance. The original estimates for Holborn Head were, I think, 4,600*l.* for a small harbour light; and the dwelling, taking the criterion of the other lights for that, would in the same way have represented about a sum of 1,400*l.* It was suggested to the Scotch Commissioners that, for a small harbour light like that, a house with a light at the gable of the keeper's dwelling would answer all the purpose, and so, save a tower. The Trinity House, without any suggestion, adopted that very plan shortly afterwards for a harbour light at Harwich. I had suggested it for Holborn Head before, as I had seen even first class lights, when height was not required, on the Danish coasts, of the same kind, where only half a circle required to be lighted, the lantern was fixed at the end of a gable, and it answered all the purpose of a tower at a much cheaper rate. And if I had been responsible for erecting lights, in the case of all harbour lights, and in several cases I think on the west coast of Scotland, where the height of a tower was not required, I would, at much smaller cost, have given the necessary efficiency to a light in that manner. At Holborn Head the Commissioners adopted our suggestion to a certain extent, but they have connected a small tower with the dwelling which has reduced the cost to 1,200*l.* or a little more than that. At Holborn Head there is every facility for building keepers' cottages as cheaply, I believe, as you can build one in any place in England. The old red sandstone that would have to be cut out for the foundation is a good building stone. No material from a distance would be required of that kind. There is a village close at hand, where people would reside, and a town a small distance off, and I cannot fancy any place therefore where works ought to be executed at a lower rate than at Holborn Head. The lighthouse on Languard Point, at Harwich, is of brick material, which has to be conveyed there, it is on a single point requiring a more expensive foundation. For that foundation they asked 200*l.*, and for the house 800*l.* more; the light will be placed in the gable, and allowing that a fourth-class light, which is the only one in question, could be placed for about 600*l.* in that gable, which I am convinced it could be, or certainly for 700*l.* or 800*l.*, the whole expense of that would be reduced to about 1,600*l.* or 1,800*l.* Now at Holborn Head there is the additional cost of a road and walls, but certainly in no way could that run up an additional 2,000*l.*, and from the tenders that have been made for the building portion of the work the cost will, I think, be considerably under the original estimate although probably not the amended estimate that was made after we had discussed the question in correspondence with the Light Commissioners. I am convinced that a much cheaper class of dwelling and building altogether, with equal strength and durability, might have been adopted for this class of light; and the more I have seen and gone into the question, and discussed it with Messrs. Stevenson, the more I have heard their objections the more am I convinced that we have not taken a wrong view on these points, and I am sure that there is no reason why the

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ings in Scotland should cost so much more than in England or in Ireland. I mentioned this subject to a gentleman of property residing in the highlands in an out of the way place, and he was astonished when I told him what the dwellings cost. He told me that he had just had two ornamental lodges, containing four rooms each, built for his park, that they were built of the best materials, and handsomely constructed, and that they had cost him 500*l.* a pair. And surely, if these are facts, it cannot be necessary, at least in a place like Corran or Holborn Head, that more than double that sum should be spent for two keepers' dwellings. I think that taking the average of the Trinity House dwellings they cost about 1,000*l.* a pair, or something less; but in one very exposed place at Sennen's Cove four dwellings for the keepers have been built for 1,000*l.* That is an out of the way place on the Cornish coast, and farther from a town than Holborn Head is. An application was made, at first privately to me, from parties who were interested in a harbour light on the west coast of Scotland on an island; all I could do was to refer them to the Scotch Board. I was told that the late Mr. Stevenson had long ago selected this very site for the purpose, but that it had been given up. I said that we had no power, and that it must come through the Scotch Board; but I was anxious to see what means existed in this island for erecting these buildings, and I asked a person moving in the matter whether they had the means of building, in the island, the necessary works. He said that there was a very good builder there, that there were persons in the island, who were interested in getting this light, who would render every assistance, and that he was sure it could be done at a cheap rate. I asked him, whether he would ascertain from the builder there what a dwelling for a keeper, with the necessary fittings for a light, could be erected for; that it must be all of the best material, strong and durable, and fit for a respectable keeper to live in. Shortly afterwards he sent me a sketch made by this builder of a dwelling in which he only gives two rooms to each keeper, and a little tower attached to the dwelling; there are four rooms, but the rooms are much larger although fewer in number, they are 16 by 13 instead of 12 by 13. But, allow that it is 40 per cent. under what the accommodation for the Scotch houses could be given for. There is a little tower proposed to put the light on, and he offers to build that light-building of the best material for 350*l.* Now I have not any doubt that if I had the entire management of putting a light in that island, that I would put a very good harbour light there, with buildings as strong and durable although not as handsomely finished as Mr. Stevenson's, and that at the outside it should cost no more, complete, than from 1,200*l.* to 1,500*l.* I believe 1,000*l.* I cannot have the slightest doubt about it. And that, I think, goes entirely to confirm my opinion, that the style of those houses is unnecessarily expensive. I may mention one thing that took place in my presence when we entered those little houses at Rhu Vaal, which only gave three rooms, although too well finished for the keepers. One of the Elder brethren who was with me exclaimed "I do not wonder now at the Scotch dwellings being so expensive when I see how they are finished; we are content with iron bolts, but here, everything is brass." Then merely on our representation Mr. Stevenson allows in his evidence, that on two of those dwellings, in ornament alone, in cut stone and cornices to the rooms, the amount has been reduced by 181*l.*; and I think that justifies the opinion we had formed, that the original plans were unnecessarily expensive, and that we were right in endeavouring to reduce the amount before we sanctioned the expenditure.

939. (*Mr. Graves.*) Seeing that the Northern Commissioners assert that they cannot get an efficient lighthouse and suitable dwellings built on the Iron Rock at a less cost than Mr. Stevenson's estimate, and

that the Board of Trade will not grant the sum required, the question is naturally suggested what will be the practical issue of this difference of opinion?—I believe it might easily be settled if there were not difficulties connected with the triple government. About two months since the Scotch Commissioners wrote to us enclosing a letter from Captain Graham, of the clansman, showing the importance of having a light in Jura Sound. In the letter Captain Graham particularly dwelt on his anxiety one night in passing the rock, because he did not know how far he was from Dunan's Head in consequence of the darkness of the night. On that we wrote to the Northern Light Commissioners suggesting that as Dunan's Head would really in a great measure answer as well as the Iron Rock, at all events as the light could be put there for half the cost of the light and dwellings for the Iron Rock, and might answer all the purposes required of a light in that channel; we suggested to them whether they could not re-open the question by proposing a light on Dunan's Head, and that we should be quite ready to grant the necessary sanction for the outlay as quickly as it could be done, that the light might be proceeded with as soon as possible. My own conviction was, and is, that that was the best way to meet that difficulty, that while it would reduce the expense greatly, both of the first cost and the maintenance, it would equally supply the wants of the trade in that sound. The principal trade requiring a light there consists of the few steamers that run two or three times a week up and down that sound, and only for them would the expense of the light be justifiable, and on nautical grounds I am convinced myself that a light on Dunan's Head would afford those steamers as much safety for passing the Iron Rock, as if it were on the rock itself. I was in hopes that by suggesting this to the Northern Light Commissioners we might get over the difficulty, and get the light so much wished for by Captain Graham and his friends. The Scotch Commissioners replied to the effect that they could not re-open the question, as it had been decided to be on the Iron Rock, in fact as it were going on the difficulty of their re-opening the question when the Trinity House and Board of Trade had already decided that it should be in another place; at all events shewing that they would not meet our views half way in order to get this question settled, and so it rests at present. Since that time I have seen Mr. Stevenson and Mr. Cunningham, and they both expressed their opinion that they would be quite satisfied with it on the rock. Mr. Stevenson said that it was in accordance with his previous opinion, and that if we wished them to put it on Dunan's Head, in order to save the expense, they were quite ready to do so. But we could not do that without exercising the power which we have never yet exercised, and do not wish to do. But I am in hopes, with the concurrence of the Trinity House and the Northern Light Commissioners if they will not stick on the formal point and will meet us half way, that we shall get the light on Dunan's Head instead, which will I believe answer all the purposes of the trade, and be more in accordance as to expense with the small toll obtainable and with the trade of the place.

940. (*Chairman.*) Without impugning the reasonableness of the proposal made by the Board of Trade, and without questioning the practical merits, nautically speaking, of that proposal, from what clause of the Merchant Shipping Act do you gather that the Board of Trade can take the initiative in a question of placing Lights on or lighting our shores?—Our letter to the Northern Light Commissioners shows that we distinctly wished them, in accordance with the Act, to take the initiative by re-opening the question, and by making a proposal through the proper channel, because we did not wish to exercise the authority that we might exercise in directing them to place it there without their doing so; and that is the real difficulty that we now labour under. As they rested their

case so much upon the letter that was written by Captain Graham, I was anxious to know his opinion upon this point; and I wrote to him asking him for it, and this is his answer:—"In reference to the proposed light in the Sound of Jura, I am of opinion that the Iron Rock is the proper site for a light in that locality; but, under all considerations, of the extra expense of building and maintaining the same, and also the higher rate of toll that would be levied on ships passing, perhaps Dunan's Head would be most advisable. I see no really serious objection against the light being erected on Dunan's Head. The steamers, which I am sure represent more than half the traffic of the sound, would have no difficulty in passing by safely if the light was shown on Dunan's Point. On the night referred to in my communication to the Northern Light Commissioners I would have had no difficulty at all if the light had been shown on the Head." Now I think that quite confirms the opinion that we had previously expressed to the Northern Light Commissioners, that if they would agree to this alteration it would meet the wants of the trade, and do it at a cost more in accordance with what would be justifiable for such a trade. Captain Graham goes on to say:—"I do earnestly hope that we will get a light somewhere soon in that locality. I was born in sight of the Iron Rock, and still it gives me more anxiety to pass by it safely than all the other rocks between Glasgow and Stornaway." I may say this, that the sailing vessels in that channel are very few, and I have not heard of any accident to one on the rock. There would be still the advantage of a beacon on the rock, and a small band of coloured light thrown from Dunan's Head across the rock would keep vessels, working up and down, clear of it when standing across. That it is only a reasonable proposition that this saving should be made, I think is shown by a case on our own coasts, where a somewhat similar point was decided by the Trinity House alone. Those who know Falmouth harbour will recollect the Black Rock, in the middle of the harbour, which, on a small scale, is exactly like the Iron Rock in the middle of Jura Sound; but, as the channel is much narrower than Jura Sound, it is of course more dangerous to vessels than the Jura Sound channel. If cost had been set aside, there is no doubt that a lighthouse on the Black Rock would have been the best position for vessels entering Falmouth harbour, because it would light both channels for vessels coming in, and would enable them to go as near the rock as was safe; but the Trinity House put the light on the main point, and put the beacon on the Black Rock, and that has answered the purposes of a very large trade; so much so that in 24 hours I have known 170 vessels, both during the day and night, pass in safety into Falmouth harbour. For that immense trade a beacon on the rock, and a light on the point, are sufficient; and certainly for a very small trade, that will not pay one eighth of the cost of maintenance, a similar arrangement would be quite sufficient. If the Northern Light Commissioners would not stick to the exact form on this question, but would be prepared to meet us half way for the sake of getting this light there, I have no doubt that it could be proceeded with next summer. I may add fairly that this shows the great inconvenience of dealing with two, and still more with three, governments.

941. (*Mr. Gladstone.*) The Irish lighthouses have been constructed usually at about as great an expense as the Scotch lights. Have you had any occasion to complain of the expense in recent erections in Ireland?—The only erection in Ireland since I have been at the Board of Trade that has led to a question of expense, I think, is the case I have alluded to; namely, the dwelling on the Calf Rock, in which case we made them reduce the expense. But, judging from the estimates of the cost of the

lighthouses on the Calf Rock and on the Black Rock, and comparing those with such lights as those of North Unst, the Butt of Lewis, and the proposed light on the Monach Islands, I should think the cost of the Irish lights very much less in proportion than the Scotch lights; for instance, if we take the Calf Rock, it is a rock very much exposed, that can only be landed upon occasionally, with the whole Atlantic Sea coming in against it, and affording, I should think, at least as difficult, if not a more difficult, site than North Unst. But I speak of North Unst with more reserve, because I have not been there. I judge only by the estimated cost, which is confirmed by the tenders that we have now sanctioned, and which is, I think, not more, but much less, than the cost of North Unst; the estimate for the Calf Rock is only 17,400*l.* That is the sanctioned tender, both for the lighthouse and all the works necessary on the shore, including the dwelling houses. For Black Rock, I think, the tenders are 15,000*l.*; very little more than the estimated cost of the Monach Island and the Butt of Lewis Lights, the former, I think, being 14,000*l.*, and the latter being 12,000*l.*, while there is no comparison as to the difficulty of the situation. The estimate for the dwellings on the Black Rock, where the difficulty of landing is so immense, and where everything will have to be taken up, I believe, on inclined planes, is only 1,500*l.*, no more than for the ordinary dwellings of the Scotch lighthouses in small stations, such as Pladda and Carran, and less considerably than the estimates for the dwellings either on Monach or the Butt of Lewis. While I have been speaking of the cost of the Scotch dwellings as 1,400*l.* and 1,500*l.*, I have been taking the lowest rate of estimate. For the Monach group the estimate alone is above 2,000*l.*, for the Butt of Lewis somewhere about the same; and yet in the Monach group there is a beautiful landlocked cove, where vessels can lie in perfect safety. Everything could be landed close to the spot, while at the Black Rock everything has to be landed with the greatest difficulty, only in fine weather, and to an extent that cannot be compared with the difficulties on Monach and the Butt of Lewis. At Question 74 this appears:—"Were they all Scotch tenders?—Yes. In other cases the commissioners are prohibited from advertising by the Board of Trade for their tenders, such as for lanterns and apparatus, and they are directed to transmit the specifications to certain specified houses in England and Scotland." That is quite a mistake. We have, as a rule, said that as to buildings it should be done by general tenders, but we have never said that the more important works, such as lanterns and apparatus, should not be done by general tenders. Then Question 750 and the answer are these:—"Was the original plan of the Commissioners of Northern Lights with regard to the height of the Caimbulg beacon carried out?—"It was originally intended to be higher, but, by the directions of the Board of Trade, the beacon was cut down." Mr. Stevenson there alludes to a beacon having been cut down. It is true that we requested them to reduce the expense, which would reduce the beacon from 40 to 30 feet. A reef of rocks extends a very short distance from the land, and there are many parts on our coasts which are quite as dangerous without a buoy or beacon, and if it were not such an exposed coast it is a place where a buoy would answer every purpose, and no more than the expense of a buoy would be justifiable. Therefore, a beacon that will always show from 15 to 20 feet, I think, above high-water mark, and which will be so much more conspicuous than any buoy would be, certainly answers all the necessities of the case, and therefore it was a case in which we might fairly expect to get it done at a more reasonable cost than that at first proposed for a 40 feet beacon, and that was the reason for wishing it to be cut down. There is another case of the Tuesdale beacon in the Isle of Man. Mr. Steven-

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son proposed one of those large and expensive cast-iron beacons: it is in a narrow channel where it is not wanted to guide a vessel to the Channel—the land does it, and it is only when close in, that a vessel requires to pass the danger, and therefore a large beacon is not necessary. A short time before, the Scotch Board had erected a small class of wrought-iron beacon, costing, I think, only 80*l.* on the Calliach Rock, and it seemed to the Board of Trade that a beacon something of that class, which would be less expensive, would answer the purpose better. Mr. Stevenson gave a plan and estimate for a beacon of that construction, which he said he would not recommend, as he preferred the other, as he considered it in the light of an experiment; but the estimate was, I think, a little more than half the cost of the first proposed beacon, and the size of it would answer all the purpose. The Board of Trade considered that it would be a fair case for testing one of the new wrought-iron beacons, which was so much cheaper, in a site of that kind, and therefore that they would approve of that beacon, notwithstanding Mr. Stevenson not being answerable for its durability, as a desirable experiment; but, if it succeeded, it might lead to reducing the cost of the beacons; and I think that that was a proper thing to do under existing circumstances. The next case that I have to refer to is that of the Unst boatman. It was proposed to run a telegraph from the island to the shore, and a permanent boatman had been sanctioned for that shore station on the ground of his being required to go up the lull, I think, to look out for signals daily. We said that if this telegraph was carried to the houses of course this man would be unnecessary; and as for a rock station alone, I do not know of any case where permanent boatmen are kept, but that boatmen are hired for the occasion, or it is done by contract; it was thought that if he was not necessary for a signal man, which was the ground on which he was made permanent, his expense might be saved annually, and so make up somewhat for the cost of the telegraph. The Scotch Commissioners refused the telegraph on those conditions, and they said that the boatman was necessary. Now as fishermen can be hired there to man the boat. I see no reason why the boat's crew could not be hired periodically, or when required, as they are at other stations both in England and Ireland, and I believe in Scotland, where no permanent man is kept. And therefore, because they still insisted upon having this signalman to look out for signals under the name of a boatman, we refused to sanction the cost of the electric telegraph. The road for the signalman, if he was retained, was not necessary over plain open moor ground like that; and we stated that if there were any difficult passes where little bridges were required, we should have no objection to the outlay; but that to make a road of that distance to the hill, to enable him to walk over, we thought unnecessary, and we refused it.

942. Was it not the case that he was upon one occasion nearly lost?—I am not aware of that; but it was distinctly stated to them, that if there were any difficult passes or water-courses which made it dangerous for him to cross, we had no objection to the expense of making them safe, but that a road over the open was not required. My recollection is that that followed the telegraph; but at all events, if the telegraph was adopted, it was certain that the road would not be wanted. If the telegraph was adopted, I cannot see why the signalman was wanted; the signalman was asked for and sanctioned, not as a boatman, but distinctly as a signalman; and it was only when the telegraph question was raised that it was said he was wanted to be retained as a boatman. Then came the question of beacons and buoys, as to colours; and I wish merely generally to state that I am quite certain, as a general principle, that it is not safe to mark the sides of channels by red and black buoys. I have had probably as much experience as any person in marking channels; for

example, in the Baltic, where we had an immense deal of that to do, putting down marks for vessels to go through, at short notice; and we found nothing so good to prevent a mistake, whether for large or small vessels, as a parti-coloured buoy on one side, and a dark-coloured buoy on the other, because they could not possibly be mistaken; and I adopted, there, red, and red and white, or black, and black and white. I believe, with regard to red and black, that they are apt to be mistaken for each other, and I cannot consider them safe, and that is why I should not recommend their being sanctioned without clearing myself of the responsibility of adopting those colours. I may instance, in order to try the question, that when going down the Swin, with the Elder Brethren, discussing this point, after Lord Clarence Paget had mooted the question, I was asked suddenly by one of the Elder Brethren of the Trinity House, "What colour is that buoy?" We were approaching it in a certain light. Others were asked; and I think we were evenly divided in opinion, for about half said red, and the other half said black; but as we drew up to it and got it in another light it was seen, I think, to be black; but there was quite a difference of opinion until then. In going into Barnstaple, in the "Banshee," with the Harbour of Refuge Commissioners on board, we were approaching a buoy, and I asked all the gentlemen on the paddle-box the question, "Is that a black or a red buoy?" Some pronounced it black, and some pronounced it red; but as the light changed some of them changed their opinions, and as it came alongside I think that it proved to be a red buoy. It was utterly impossible for a stranger, who had to pass on one side of a black buoy, and on the other side of a red buoy, that he could have known on which side safety lay. Whether you use red or black is of less importance, so long as you have the other side stripes or checkered. I am convinced that the best is to have black on one side and checkered on the other, or red on one side and checkered on the other—and it was on that ground that we suggested it to the Ballast Board for Lough Swilly.

943. (*Mr. Graves.*) Do you approve of one general system of buoys?—I think it is desirable to lay down one uniform system; that is, I would endeavour, in buoying all new places, to establish this system,—that black or red buoys should be on the one hand, and black and white or red and white on the other. In the same way, if buoys have beacons on them, on one side, where the one colour is, there should be one ball, and on the other side, where the two colours are, there should be two balls. That system has now, at my suggestion, been added to our naval signal books for buoying and beaconing channels, and I drew it up at the request of Admiral Hope and others who were employed to revise the signal book. I am sure it is the right system; but I would not think of breaking up the old and well-established system of buoys in places where every man in a coaster knows them well, merely to change them to this system; I would try to bring it about wherever I could, and always adopt it in new places; but I would not try to break up so well-established a system as that at the entrance to the Thames, where there are several channels.

944. (*Chairman.*) With respect to going in to Barnstaple, Mr. Campbell wishes you to be asked whether there was any other buoy that might be compared with the one colour which you were uncertain about?—I do not recollect at this moment; but I may say that a black buoy gets rusty, and a red buoy becomes black as it gets dirty, and that increases the difficulty, particularly in different lights.

945. (*Mr. Gladstone.*) Do you think that your objection applies equally in a bright light as in a dull light?—It is more difficult, in the bright light of the sun, to distinguish them, than in any other; but I cannot fancy anyone mistaking a striped or checkered buoy for a dark buoy of one colour.

946. (*Mr. Graves.*) How do you mark the centre danger according to your system of buoyage?—The only point that would require a different class of buoy would be the divergent point at the two ends of a bank, which could always be marked by a particular beacon buoy, and perhaps a white buoy; I do not like them generally; but they might answer the purpose with beacons. Where you have a divergence forming two channels, you would follow the rule in each channel as in a single channel.

947. The Commission have taken the evidence of 657 mariners on the question of the colour of buoys, and 408 out of that number have given their preference for black, and only 13 have expressed a preference for checkered?—I should quite accord with them if I had merely to decide what one buoy to mark one danger should be—the darker the buoy the better, and therefore black. But if they had been asked what buoy would you place on the opposite side of a channel? I think the majority of them would have told you, a black and white buoy of the same kind, in preference to a red buoy.

948. Seeing that you rather agree in the fact that it is difficult to alter the established system, is it not reasonable to ask you why you should not adopt the most approved system of existing buoyage rather than adopt any one different from what is carried out in England, in Ireland, and in Scotland?—I do not think, that because a parti-coloured buoy is adopted, it can be said that we should adopt a new system. It is very much used on the coast of England, more perhaps where there are single channels, for example I may instance Yarmouth. The Scotch system has only been adopted recently, or within the last few years, I think, so that I do not believe it is an old established system. The Irish Board had certainly commenced no system of the kind until, I think, they proposed to adopt it in that very place where we suggested the other alteration.

There is another point, with regard to the expenses of management which will be found at Question 830, and which has been called in question by the Scotch Commissioners, as to the per-centage. In giving my evidence before the committee on merchant shipping I took roughly the whole expense of the maintenance of the lighthouses, and the cost of management. I did not allude at all to the outlay on new works, as comparing the actual expense of managing the lights with the expense of maintenance during the year; I have now, in order to see whether I was wrong, made a more careful estimate. If you take the actual cost of the maintenance of the Scotch lights, buoys, and beacons, it amounts to 19,400*l.*; the salaries, superannuations, and office expenses, due to the management alone, amount to 3,868, so that the actual per centage of management, compared with outlay on maintenance, is 20 per cent., instead of 16 as I said before. If you include new works also, and so take the whole outlay, and then the expense of management, and add the engineer's expenses, which I have not included, and the miscellaneous expenses to the others, and compare that with the whole outlay, I find that the cost is 11 per cent. I find that taking the same comparison of the Trinity House under the first head it would be about 21 per cent. for management, and under the second head, if the new works are all included, 15 per cent., both of them higher than the Scotch. If I take the Irish, I find that under the first head it is only 7 and 3 10ths per cent., only one third of the Scotch, and under the second head 5 and 7 10ths. Mr. Stevenson has made a mistake in saying 16 per cent. upon their revenue—my comparison was on the outlay. Mr. Stevenson has said that we objected to the cost of the lantern at Holborn Head because we had had an estimate from Mr. Wilkins of a lower amount. It might appear that we had had an estimate from Mr. Wilkins for a similar lantern to compare with Mr. Stevenson's, but we had nothing of the kind. I only took what we had last paid Mr. Wilkins for a similar

ordered for the colonies, and compared it with that. There is one point, and one which I have only recently discovered myself. In some cases for colonial lights, when the principal makers of the apparatus and lights have recently competed for a light at home, in order to save time and trouble, if the one who gained that was willing to take the one for the colony at the lowest tender that he had taken for the other, we have given it to him also, and in asking Mr. Wilkins if he would take the light that we were ordering for the colony at the same cost as he had taken and made a lantern for the Ballast Board he said no, because this light was to be done on the Trinity House specification, and he could not do it. I asked him what the difference was, and he said, that the Trinity House had the metal filed smooth, and the Irish Board had the rough casting painted. I was perfectly astonished to find that this finishing alone cost more than one third the value of the lantern. I then asked him whether if we had these lights finished, not on the Trinity House specification, but on the Ballast Board specification in the rough, he would take it on the Ballast Board cost of the lantern, and he did it directly. I asked him whether there was any advantage in the other mode; and he said that it was in the finish only, but he thought that it took the paint better when rough; it was not painted when finished; but in use and durability there was no difference. That may give rise to a question with the Trinity House. I think that the lantern is just as good in the rough painted, and we have adopted it since for those that we have ordered for the Red Sea. I think it is a fair thing to ask the Trinity House and the Northern Light Commissioners to do the same, in order to save the expense in lanterns in future.

949. (*Mr. Graves.*) Have you formed any opinion as to the advantage of Herbert's Fair Way Light, or of the possibility of keeping it moored?—Yes, we have given our opinion upon that, and it is an unfavourable one. The first principle, as to lighting a channel, I think is a question quite open to discussion, but my opinion at present is against it. I would rather light the shores than mid channel.

950. (*Chairman.*) I thought that this was a principle of keeping shore lights, and adding the mid channel?—Where there is no danger in the channel I would not add lights merely to mark the roadway. Another proposal for using such a light was the to mark the dividing point between the two channels, or to give, as it were, a landfall to vessels coming into soundings. I think that would be a better use for the light than merely to mark the centre of the channel, but I do not think it is necessary. We have now a good light exactly on the dividing point at the outer danger at the Scilly Islands, and the only advantage in a light further off would be that it might prevent a vessel occasionally getting on the wrong side of the Scilly Islands; but if the weather is so thick that she cannot make the Bishops light so as so as to know which side she is going of the Scilly Islands, it is hardly possible that she would hit the other vessel, in that weather, further outside; and, therefore, the only time apparently that the more advanced light would be wanted, the chances are a hundred to one almost against her making that light. Then, again, with regard to the class of lightvessels proposed, however much some may approve of Herbert's plan of mooring beacons, or even lightvessels, I can hardly fancy any one adopting such a plan for such a position as that, in preference to a well-tried form of light vessel, which would be, I believe, far safer generally than such a structure as that. In the first place, if they break adrift, a lightvessel is manageable, and there is no danger to her crew; but if one of these break adrift it may cause the destruction of every man in her, and, for that reason, the Board of Trade was against trying it in such a position, for instance, as the Stones off Godrevy, because we would not take the responsibility of risking men's lives in a structure

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which, if it did break adrift, must take them to certain destruction, whereas a lightvessel can hoist her sails and make for a place of safety. Then another reason why I do not think any one would be justified in trying such an experiment is, that the large beacons which have been constructed for the purpose of trying it have not yet had a satisfactory trial. The one that was tried on the Goodwin Sands disappeared, and I believe has never been discovered. The one that was moored off the Godrevy Reef broke adrift soon after being placed there, and therefore I think that shows that it would not have done to risk men's lives in a structure of that kind. I had forgotten one thing in connexion with Godrevy, which is, that in addition to the light which the Trinity House recommended, the Board of Trade suggested that a large buoy or beacon should be placed on the Stones to add to the safety of vessels rounding it.

951. (*Chairman.*) Can you state to the Commission when there will probably be any exhibition of the electric light for illuminating a lighthouse?—The time entirely rests between the Trinity House and the patentees; all that the Board of Trade has done has been to sanction the necessary outlay. I believe there has been some new idea of placing another tower for it, which was started by the patentees; that is, a person very much interested in the matter called upon me to ask whether such a thing would be sanctioned, under the idea that an iron tower, of 120 feet in height could be placed on a loose shingle foundation at Dungeness, for about 1,400*l.*; and when I stated that an iron tower of that height, without a lining—a plain skeleton tower—erected in the maker's yard in London for inspection, and delivered on board a vessel, cost above 6,000*l.*, and that to that would have to be added all the cost of the foundations in Dungeness shingle, I think the opinion was entirely altered, and I have not heard anything further on the subject. It therefore rests with them. There is one point in Admiral Gordon's evidence, touching upon that, that I should like to make a remark upon. There appears to have been some doubt whether Dungeness was a proper site for trying that electric light. At first my own idea was, that such a point as the Start would have been a better point; but when I understood that neither those Elder Brethren who had witnessed the trials nor Professor Faraday were sufficiently satisfied with its capability for a revolving light, to warrant the experiment, I completely gave up my opinion; and as it had to be tried upon a fixed light, and as Dungeness lantern and light were at that time about to be changed, it seemed, although not the most important position on the coast, a right and proper position in which to try the electric light, because, if it did not answer, less expense would be incurred in doing it.

952. You are a member of the Thames Conservancy Board, are you not?—Yes.

953. Do not the duties you have there to perform necessarily occupy a good deal of your time?—It generally takes me two days a week. If there is anything important that I know of at the Board of Trade I give up the Conservancy for that day, and go to the Board of Trade in preference; or if the work has accumulated, so that I have left any papers unfinished the day before, I should probably endeavour to get away early from the Conservancy Board and finish the day at the Board of Trade; but that rarely occurs. I am generally employed the greater portion of the day at the Conservancy Board, and that leaves me quite time enough, on the other days, to do the work at the Board of Trade.

954. I see that the Thames Conservancy has placed a very effective light at Northfleet, which you are obliged, by courtesy to the Trinity House, to call an illuminated beacon, and it is lighted with gas at a very small expense. From the experience that this light alone, which is under your own conservancy, has afforded you, would you not be favourable to the introduction of gas where possible in lighthouses?—

I have not seen that light lighted, not having been down there by night, but I have seen gas in lights on the coast, and I should certainly be favourable to the introduction of gas wherever it could be introduced, on the score of expense. I do not think that experiments have been made up to the present time sufficiently to tell whether it would equal the power of a first-class light, but I do not see why arrangements should not be made for making gas answer all the purpose. I think that if I had to give an opinion upon the point, and a lighthouse was to be lighted where gas was within reach, I should hesitate before I recommended that the expenditure for a lamp should be sanctioned, if gas could be obtained.

955. I may assume, that if the Trinity House or any lighthouse authority came to the Board of Trade with a request, that a certain small sum might be allowed for experiments in gas, that the Board of Trade would be quite ready to sanction it?—Most decidedly. I think there has been no instance of any sum that has been asked for, large or small, for experiments, being refused. I cannot recollect an instance, from the smallest sum up to the sum necessary for the electric light.

956. Can you inform this Commission whether any lighthouse authorities have applied to the Board of Trade for permission to make experiments in gas?—No; I am not aware of any. While on that point I should like to say one thing. As I have, on several occasions, to a certain extent, called in question Mr. Stevenson's estimates, and the expense of his structures, I wish to put on record my opinion that his works are most beautiful; that they are, I think, equal, if not superior, to anything I have seen, and that it is to Mr. Stevenson we owe the present state of our lighthouse illumination—for the improvements on the Fresnel light which he has made have really given us the superior class of lights that we have now in England. All that has been done, that I can see, to improve on the system, and to give us a better class of dioptric light, has been done by Messrs. Stevenson, and I believe that that is quite the feeling of every one at the Board of Trade.

957. Are you quite satisfied with the machinery which has been at your disposal hitherto, for conducting the business connected with the erection of lighthouses in British possessions abroad?—I think that we require more fixed engineering advice. I think that any Board that has to carry out lighthouse work should have a permanent engineer attached to it, whose duties would be confined to that subject, and who would do it satisfactorily. Hitherto the Board has, in carrying out colonial lights, obtained what was considered the best class of professional assistance in London; but I do not think that on the whole it has been satisfactory. The system of erecting lights in the colonies with materials, as well as the working staff, sent out from England has not, I think, been a good one. I will take the instance of the Bahama lights. The Great Isaac's light was handed over to the Board of Trade by the Admiralty; but the Cay Lobos light, at the suggestion of the engineer engaged by the Board of Trade, was erected of iron, sent out from England, together with its whole foundation, and the working staff to erect it. The cost of that iron tower and buildings has altogether exceeded 24,000*l.*, and I believe that lights can very often be erected, with material and means to be found on the spot, at a much lower cost than in the way in which they have been erected by sending the material from England. I was told that it had been done in consequence of the Bahamas not affording any material fit for erecting a lighthouse; but, on the question being put to an engineer resident in the Bahamas, he gave a very decided opinion, that all the material necessary, both in stone and wood, was obtainable in the island. And for a particular site, at our request, he furnished us with an estimate for building a tower and dwellings for a lighthouse at about 5,000*l.*, which, with the lantern and appa-

ratus sent from England complete, would not exceed 8,000*l*. I believe, judging from the Cay Lobos light, that if an iron tower, necessary for the light in question, were sent from England, with people to erect it, it would cost nearly double that sum. The engineer employed by our consulting engineer to erect the Bahama lights was requested to furnish us with a report on the sites recommended for new lighthouses before he returned, and he gave us a very valuable report on the different sites, with plans and sections; but he reported, in nearly every case, that there was no material to construct the towers, but that iron towers must be sent from England. In proof of his statement he brought home specimens of the stone; and in the case of the very worst quality of stone, which the reporting engineer had pronounced to be totally unfit, but which the colonial engineer declared to be quite fit for the purpose, we have had it tested as to its strength by Mr. Coode, the engineer of the Portland breakwater, who has pronounced it capable of bearing a weight seven times as great as that which it could be called upon to bear by being used for building, and therefore confirming the opinion of the colonial engineer. There are other qualities of stone in other sites, which are still superior; and there can be no question that, in a hot climate, a stone tower is far superior to an iron one, on account of the heat; and I cannot fancy any case in which an iron tower, sent from England, can be desirable, unless in a case where there is no material to be found. The only instance in which we have sent out material which has been erected at a cheap cost has been in the case of King George's Sound, where a small tower was sent out, but no workmen or staff, from England. It was erected and dwellings built round it by local means, and a second dwelling for a small harbour light with

the same means, and the works were erected under the superintendence of a sergeant of sappers, who acted under the orders of an officer of engineers on the station; and the larger light of the two has been erected with its dwellings, and the smaller light placed in a dwelling in the harbour, at a cost altogether of 5,000*l*., which is the cheapest work of the kind that has been done. To the Cape of Good Hope iron has also been sent out, and I think quite unnecessarily, for I believe the stone on the spot might have answered all the purposes for one at least of the two lighthouses. Another iron lighthouse has also been sent to Cape Race, and certainly there are great complaints of it for that climate; and I do not think it is likely that the Board of Trade will again erect a single lighthouse in a colony where, by any means, material can be found on the spot, and superintendence, material, and workmen. I should not myself advise the use of iron lighthouses anywhere where they can be possibly avoided. I may mention, as an instance, Vancouver's Island. We decided to have two lighthouses constructed by colonial means, and I gave, roughly, a very low estimate for the construction of those lighthouses, compared with what iron lighthouses had cost. Both of them are on small islands, one some way from the main, and they have been erected with local means. The lanterns and apparatus were sent from England; and although labour has been unusually high, from the state of the colony, exceeding 1*l*. a day for some workmen, the cost has not very much exceeded our original estimate. I think that the two lighthouses, one being on a tower of 80 feet high, with a second-class revolving light, and the other, a harbour fourth-order light, on a low tower, will not cost altogether above 12,000*l*.

Capt. B. J. Sullivan, R.N.

1 Feb. 1861

The witness withdrew.

Mr. THOMAS STEVENSON, C.E., examined, received February 4th.

958. (*Chairman.*) From your experience of the Board of Northern Lights, do you consider that it is necessary that an engineer should be present at every meeting of the Board?—In my estimation such constant attendance is not absolutely called for. The whole ordinary management of the lighthouses, stores, and shipping are quite foreign to the profession of civil engineering. It seems to be sufficient that the engineer should attend on presenting a report on any matter that may have been remitted to him, or in laying before the Commissioners reports on new works in progress. I often found it to be a very great waste of time to be obliged to make arrangements to attend meetings when my presence could be of no use whatever.

959. Do you think it is an advantageous arrangement to restrict the engineer to a Board from

engaging in general business?—No, I do not; and it is not consistent with my knowledge that Boards or public companies employing engineers do so restrict them. If a man is so isolated he is very apt to lose energy and fall behind in his professional knowledge, whereas, if he engages in general practice he is brought into contact with the men in his profession, his views and experience are enlarged, and he is the better able to deal with the difficulties he may meet with. It generally happens too that one branch of engineering throws light upon another. For example, if the lighthouse engineer be also a harbour engineer, he will find that the knowledge of the action of the waves which he is constantly acquiring in his experience of harbour works, will be of the highest value to him in designing beacons and light towers in exposed situations.

Mr. T. Stevenson, C.E.

4 Feb. 1861.

CAPTAIN SULLIVAN re-examined.

960. Have you any observations to make in reply to the statement of the Commissioners of Northern Lights, a copy of which has been shown you?—I think nearly every point in that statement has been answered in my previous evidence, but there are two mistakes in the statement which I must correct. With respect to the land at Holborn Head, the proprietor at first required two roads to be made, which would have caused an unnecessary outlay from the Mercantile Marine Fund for his advantage. We

refused to sanction any expense for roads beyond what was necessary for the lighthouse communication, and the result was that one road along the shore, sufficient for this purpose, has at last been agreed to. The second mistake is, that I objected in my evidence to the lightkeepers having so much accommodation. On the contrary, I pointed out that three rooms were not sufficient accommodation; and since I have been at the Board of Trade, a fourth room has been given in every new dwelling.

Capt. B. J. Sullivan, R.N.

4 Feb. 1861.

ILLUMINATING APPARATUS.

SIR, Trinity House, London, E.C. 20th December, 1860.

I AM directed to transmit to you, for the information of the Royal Commissioners on Lights, Buoys, and Beacons, a List of Contracts for the supply of Illuminating Apparatus to the Trinity House, or to other Boards through

the Trinity House, since 1st January, 1853, in conformity with the Requisition dated 21st ultimo.

I have, &c.

P. H. BERTHOX.

J. F. Campbell, Esq.
&c. &c. &c.

LIST OF CONTRACTS for the supply of ILLUMINATING APPARATUS to the TRINITY HOUSE, or to other Boards through the Trinity House, since 1st January, 1853.

Date of Advertisement.	Situation illuminating apparatus was designed for, and order of ditto.	Amount of Estimate made in Office.	Names of Contractors who tendered.	Amount of Tender.	Tender accepted.	Date of Contract.	
Not advertised.	Lundy, Holophotal Catadioptric.	No Estimate made.	Chance, Bros. - -	With Stevenson's improved revolving apparatus - £ 1,690 Without do - 1,495 W. Wilkins - - - - - De Ville & Co. - - - - -	Chance, Bros. 1,495/.	1856 : June 30.	
	* Bishop, Catadioptric -		Wilkins & Co. - - M. Sautter - - Chance, Bros. - -	£ s. 1,313 10 1,394 0 1,225 0	Wilkins & Co. 1,313/ 10s.	1858 : Feb. 8.	
	* Whitby—South, Catadioptric.		Wilkins & Co. - - M. Sautter - - Chance, Bros. - - M. Lepaute - -	778 0 885 0 778 0 2,028 0	Chance, Bros. 778/.	Mar. 11.	
	Do. South and North do.					do.	
	* Whitby—North, Catadioptric.		Wilkins & Co. - - M. Sautter - - Chance, Bros. - -	907 0 995 0 1,003 0	Chance, Bros. 1,003/.	do.	
	* Needles, Catadioptric		Wilkins & Co. - - M. Sautter - - Chance, Bros. - -	1,087 10 1,192 0 1,020 0	Wilkins & Co. 1,087/ 10s.	April 22.	
	North Foreland, Catadioptric.		Chance, Bros. - -	£ s. Apparatus - 945 0 Reflectors - 110 0 Total - 1,055 0	Wilkins & Co. 1,018/ 10s.	June 24.	
			M. Lepaute - -	Apparatus - 1,160 0 Reflectors - 32 0 Total - 1,192 0			
			Sautter & Co. - -	Apparatus - 1,165 0			
			Wilkins & Co. - -	Do. - 964 10 Reflectors - 54 0 Total - 1,018 10			
	† Cani Rocks 2nd order, Fixed Dioptric Apparatus.		Chance, Bros. - - Wilkins & Co. - -	Optical portion 806 0 Other Portion and Lantern. £1185 15s. 7d.	Chance, Bros. 806/.	1859 : April.	
				Optical Part. Framework, &c.	Wilkins & Co. 1185/ 15s. 7d.	March.	
				£ s. d. £ s. d.			
	† Vancouver's Island, Race Rock (2nd order).		Wilkins & Co. - - De Ville & Co. - - Chance, Bros. - -	1,132 10 0 1,355 0 0 1,030 0 0	371 17 0 600 0 0 385 0 0	Optical Part, Chance, Bros. 1,030/.	August.
						Framework, &c., Wilkins & Co. 371/ 17s.	do

* The tenders for these four stations were invited together, and regard being had to the necessity of providing lighting apparatus of the best material and manufacture required for the very important stations at the Bishop and the Needles, and Inspecting Committees having expressed doubts as to the equality of Messrs. Chance's lenses with those which have been supplied by Messrs. Wilkins, the Board resolved to accept the tenders of Messrs. Wilkins, although not the lowest, for the apparatus required at those two stations, also to accept Messrs. Chance's tenders for the apparatus required at the Whitby lighthouses, although not the lowest, in consideration of the non-acceptance of their tenders, for the reasons above stated, for the Needles and Bishop Lights.

† Procured at the request of the Board of Trade.

Date of Advertisement.	Situation illuminating apparatus was designed for, and order of ditto.	Amount of Estimate made in Office.	Names of Contractors who tendered.	Amount of Tender.	Tender accepted.	Date of Contract.	Trinity House contracts and tenders.
Not advertised.	† Esquimaunt Harbour. (4th order).	No Estimate made.	Wilkins & Co. - -	Optical Part. £ s. d. 101 15 0	Framework, &c. £ s. d. 72 18 7	Optical part, Chance, Bros. 89l.	1859 : August.
			De Ville & Co. - -	108 0 0	112 0 0	Framework, &c., Wilkins & Co. 72l. 18s. 7d.	do.
			Chance, Bros. - -	89 0 0	82 0 0		
	† Trincomalee, Ceylon ; Elephant Island (4th order).		Wilkins & Co. - -	117 10 0	25 10 0	Wilkins & Co., Optical part, ‡ 117l. 10s.	November.
			De Ville & Co. - -	145 0 0	50 0 0	Framework, &c., 25l. 10s.	
			Chance, Bros. - -	115 0 0	27 0 0		
	† Foul Point (2nd order).		Wilkins & Co. - -	1,115 5 0	369 15 0	Optical part, Chance, Bros., 1,060l.	do.
			De Ville & Co. - -	1,260 0 0	562 0 0	Framework, &c., Wilkins & Co., 369l. 15s.	do.
			Chance, Bros. - -	1,060 0 0	411 0 0		
	Smalls (1st order) -		Wilkins & Co. - -	Optical Part. £ s. d. 1,496 10 0	Lamps, &c. £ s. d. 174 15 0	Optical part, Chance, Bros., 1,429l.	1860 : June
			Chance, Bros. - -	1,429 0 0	190 10 0	Lamps, &c., Wilkins & Co., 174l. 15s.	do.

† Procured at the request of the Board of Trade.

‡ This tender accepted, it being considered that the gain of 4 weeks in the time of manufacture counterbalanced the small additional cost of 2l. 10s.

LIGHT VESSELS, &c.

Between the 1st January, 1853, and June 1860, catoptric apparatus was supplied by Messrs. Wilkins, and when intended for a light vessel was included with the lantern in one estimate. The apparatus for the Gunfleet Lighthouse in 1855, was distinct and the price for a "revolving apparatus showing red light by 3 lamps, and parabolic reflectors " on each face of a triangular frame " was 494l. 4s. Since 1857, the price of catoptric apparatus has been included in Messrs. Wilkins' price lists, extracts from which are subjoined, viz.,—

	1858.	1859.	1860.
Argand lamps,—Lighthouse	£ s. d. 1 12 9	£ s. d. 1 12 9	£ s. d. 1 12 9
Light vessel	2 9 3	2 9 3	3 9 3
Reflectors - Lighthouse	21 7 6	21 7 6	21 7 6
Light vessel	4 9 6	4 9 6	4 9 6
Burners - Lighthouse	1 2 6	1 2 6	1 2 6
Light vessel	1 2 6	1 2 6	1 2 6

The apparatus for the Varne light vessel was included in the same tender as the lantern, but was supplied pursuant to public advertisement, as under.

Date of Advertisement.	Situation illuminating apparatus was designed for, and order of ditto.	Amount of Estimate made in Office.	Names of Contractors who tendered.	Amount of Tender.	Tender accepted.	Date of Contract.
1860. May	Varne light vessel, floating light, lantern, and revolving apparatus.	No Estimate.	Wilkins & Co. - - De Ville & Co. - -	384l. 2s. 3d. in six weeks. 449l. in 18 weeks.	Messrs. Wilkins —	1860 June. —

Trinity House,
20th December, 1860.

P. H. BERTON,
Secretary.

SPECIFICATIONS FOR ILLUMINATING APPARATUS BY THE THREE LIGHTHOUSE BOARDS.

Specifications for illuminating apparatus. On the 28th March, 1860, a letter was addressed to the three Lighthouse Boards, of which the following is a copy:—

Royal Commission, Lights, Buoys, and Beacons,
7, Millbank Street, S.W., London,
March 28, 1860.

SIR,

I am directed to request that you will move the Elder Brethren of the Trinity House (the Commissioners of Northern Lighthouses) (the Ballast Board) to cause the Commissioners to be informed—what is the course pursued by them in ordering a lenticular illuminating apparatus for a new site from the manufacturer; and to furnish the Commissioners with copies of the plans, specifications, &c., actually submitted to the manufacturers in ordering the last two sets of lenticular apparatus of large size, or peculiar form, which have been purchased.

I am also to request that similar information may be furnished with reference to catoptric apparatus, and with as little delay as possible.

I am, Sir,
Your obedient Servant,
J. F. CAMPBELL, Secretary.

P. H. BERTHOX, Esq.,
&c. &c. &c.

On the 3rd of April the reply of the Trinity House was sent. The Commissioners of Northern Lighthouses sent their reply on the 11th, and the reply of the Ballast Board was sent on the 15th of December.

The letter of the Trinity House was as follows, and the forms and drawings referred to therein were printed forms and lithographed drawings.

In the case of the North Foreland and Whitby Lighthouses, the specification consists of one of the forms filled up, with the number of horizontal degrees intended to be illuminated, and the number of panels required, and in each case provision is made for large reflectors to be fitted in the "vacant central refractor panels." The dimensions are given, but the lithographed drawings do not include the reflectors, and no mention is made of the elevation at which the light is to be placed above the sea level.

In the case of reflector lights, as stated in the letter, there is no departure from the old system, which is, to direct Messrs. Wilkins to supply a certain well-known form of apparatus.

Trinity House, London,
3rd April 1860.

SIR,

I am directed to transmit to you the enclosed Return in reply to your letter dated 28th ultimo, relating to the mode of procedure in ordinary lighting apparatus.

I have the honour to be,
Sir,
Your most obedient servant,
P. H. BERTHOX,
&c., &c.,
Royal Commission on Lights.

"RETURN TO REQUISITION, dated 25th March 1860.

Trinity House. "The course pursued in ordering a lenticular illuminating apparatus for a new site from the manufacturer, with copies of the plans, specifications, &c., actually submitted to manufacturers, in ordering the last two sets of lenticular apparatus of large size, or peculiar form, which have been purchased. Similar information with reference to catoptric apparatus.

"As regards lenticular apparatus, the course would be to send copies of the enclosed Forms A. and B. to Messrs. Wilkins and Messrs. Deville, London, and to Messrs. Chance, Birmingham, and of A. only to Messrs. Lepaute and Messrs. Sautter (Létourneau), Paris.

"Copies of plans and specifications actually submitted to manufacturers in ordering the last two sets—those for the North Foreland and the Whitby—are transmitted. These were sent to the firms above mentioned.

"The Commissioners will observe that in these the optical portion is not separated from the lamp's framework and fitting up at the station. The plan of dividing the work has not yet been carried out at any of the Corporation's own lighthouses, but has been adopted with economy and success in regard to apparatus for certain foreign and colonial lights which the Elder Brethren have procured at the request of the Board of Trade. This course has been pursued with the view of including the French firms in the competition. The manufacturer of lamps, frames, &c., being an entirely distinct speciality to that of glass, advantages both as to quality and cheapness result from dealing with each separately.

"In the case of catoptric apparatus, the course pursued would be to order Messrs. Wilkins to furnish it, in conformity with the List of Prices offered by them, and approved by the Board, at the commencement of each year."

Trinity House, London,
8rd April 1860.

P. H. BERTHOX,
Secretary.

Scotch Board. The letter of the Commissioners of Northern Lighthouses was as follows, and was accompanied by nine large and very well executed drawings of the apparatus ordered for St. Abb's Head, and MacArthur's Head, lens lights; and for Rona, a reflector light.

Drawings. The apparatus for MacArthur's Head consists of numerous ingenious contrivances for throwing light of various colours and intensities in different directions so as to use advantageously as much as possible of the light produced. The

arrangement is styled "Azimuthal condensing," and was contrived by Mr. Stevenson. A light of this kind was visited and seen alight by the Commissioners in the Sound of Skye, and was found to be effective; a comparatively small lamp giving a very brilliant light where required, and being effectually masked elsewhere.

The apparatus at St. Abb's Head is of a less complicated description. It is a revolving light, with eight panels, and shows less design.

The apparatus for Rona is revolving, and consists of a series of reflectors of a peculiar form, fitted with lenses in front, an arrangement called "Holophotal."

All these are working drawings, the designs of Messrs. Stevenson, the engineers employed by the Commissioners of Northern Lighthouses, but who are not permanently attached to the service.

The written specifications contain full details as to the construction of nearly all parts of the apparatus, including glass, metal, and machinery.

"Northern Lighthouses Office,
Edinburgh, 11th April, 1860.

SIR,

"With reference to your letter of the 28th ulto., I am now directed by the Commissioners of Northern Lighthouses to state, that the course pursued by the Commissioners in obtaining tenders for an illuminating lenticular apparatus, used to be by advertisement; but now, under orders from the Board of Trade, the specifications and plans are printed, and sent to certain tradesmen pointed out by them, viz:—

Simpson and Co, Deville and Co., London; Chance,
Birmingham; Sautter and Co., Paris.

"I also send herewith specifications and working drawings—1 and 2. St. Abb's Head—machine and glass work; 3 and 4. Dron, Cantickhead, and Bressay Sound—machine and reflectors.

5. Mac Arthur's Head—apparatus.

"These are accompanied by eight working drawings, among which will be found the drawings prepared in the case of MacArthur's Head, to enable the light to be properly arranged in the light-room, and cut-off and changes of colour to be effectually laid off, so that the light may be of the objects for which it was designed.

I am, Sir,
Your most obedient Servant,
ALEX. CUNNINGHAM,
Secretary."

On the 18th December 1860 the following letter was received:—

Ballast Office, Dublin,
15th December 1860.

SIR,

I am directed by the Port of Dublin Corporation to state to you in reply to your letter of the 28th March 1860, that it is not the practice of the Corporation to give a specification for a lenticular apparatus. When such are required forms of tender are sent to parties competent to supply such, of whom there are only two or three in the United Kingdom, setting forth the are intended to be illuminated, the number of panels and zones required, and that the apparatus shall be of the best quality and fitted together correctly, holding the manufacturer responsible for its efficiency. Copy of a tender for a first order apparatus is sent herewith.

No catoptric apparatus has been erected by this Board for many years, nor is it intended again to have recourse to that mode of light.

I am, &c.,
W. LEES, Secretary.

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propose to supply to the Port of Dublin Corporation for a fixed light of the order dioptric apparatus to light all round the horizon with lamp, ventilating tube, stand, &c.

Of the optical portion, the glass to be of the best quality used for such apparatus, and free from any faults which would lessen the efficiency of the light; all the parts to be truly formed and finished in the best manner.

The eight panels forming a portion of a cylinder around the light, and the panels comprising the upper and lower tiers of catoptric zones are to be securely mounted in gun metal frames supported on wrought iron framing and uprights fitted to the cast iron stand. The whole to be fitted together in the best manner and to admit of being adjusted with perfect accuracy for the sum of sterling for apparatus, two lamps, two spare burners, ventilating tubes, stand, double packing cases, carriage to stores, and all charges included. The apparatus to be completed and delivered at the lighthouse stores, Northwall, Dublin, within from date of acceptance tender being notified, and to be paid for within weeks after full completion of the contract.

(Manufacturers are requested to forward to the Engineer of the Corporation an outline plan, section, and specification of apparatus proposed to be supplied.)

(Signed)
(Residence)

To the Secretary, }
Ballast Office, }
The Corporation will not hold themselves bound to accept the lowest tender.

This tender, sealed, is to be delivered (through post) at the Secretary's Office, before 12 o'clock noon, on day of above date.

The practice then of these three authorities differs widely. See *Repor.* p. 30.

CASES OF CONVICTION OF LIGHT KEEPERS FOR OFFENCES; TRINITY HOUSE.

The following Return shows the State of Discipline of the Light Service in England.

SIR,
Trinity House, London, E.C.,
1st February 1861.

I AM directed to transmit to you for the information of the Royal Commissioners on Lights, Buoys, and Beacons, a list of the cases in which keepers of lighthouses or lightships have been convicted by the Corporation of Trinity House of offences or derelictions of duty since 1853, with a statement of the course pursued in these cases, in conformity with your requisition dated 29th November last.

J. F. Campbell, Esq.,
&c. &c. &c.

I am, &c.,
P. H. BERTHOX.

A LIST of the CASES in which KEEPERS of LIGHTHOUSES or LIGHTSHIPS have been convicted by the Corporation of Trinity House of Offences or dereliction of Duty since 1853, with a Statement showing the course pursued in these cases.

1854.

Lighthouse Service.

17th January.—Principal keeper.—Receiving lodgers at his dwelling contrary to regulations.

Reduced to assistant and supernannuated as such.

Assistant at same station.—Receiving lodgers at his dwelling contrary to regulations.

Put back two steps in promotion. Severely reprimanded and cautioned.

Assistant at same station.—Receiving lodgers at his dwelling contrary to regulations.

Removed to another station. Severely reprimanded and cautioned.

11th April.—Two assistants.—Disagreement and bad feeling between them. They had not spoken to each other for 12 months.

Both reprimanded and cautioned to live on good terms for the future; directed to give a joint assurance of their intention to do so, and to perform their respective duties in a proper and peaceful manner, and acquainted that if they persist in their present course they will be removed.

1856.

9th October.—Principal.—Having communicated direct with the commandant of a neighbouring fort without the Board's permission to do so.

Charge investigated by Visiting Committee, and being substantiated, accused was reprimanded for such irregular proceeding. Cautioned to be more circumspect for the future, and desired to send any representation he may have to make to the Board through the agent.

1857.

21st and 28th May.—Assistant.—Having made use of very abusive language to principal keeper, being the worse for drink; want of cleanliness, disrespect to agent, and general unfitness for the charge of a lighthouse.

Dismissed with one quarter's pay.

18th August.—Assistant keeper.—Occasionally giving way to intoxication.

Discharged from the service.

1st September.—Assistant keeper.—Absence from duty during three nights and days, caused by drunkenness; charge admitted and reason assigned, that he was led away by bad company to witness a regatta.

Dismissed the service.

1858.

18th May.—Principal and assistant keeper.—Light apparatus found by an Inspecting Committee in a dirty and inefficient condition.

Both reprimanded and cautioned as to future conduct. Assistant put back two steps in his promotion, and removed to another station.

8th June.—Assistant keeper.—Having struck the other assistant because the latter had charged him with neglect of duty, and being generally quarrelsome.

Dismissed the service.

7th October.—Assistant.—Neglect of duty, &c.

Reprimanded and admonished as to his future conduct.

1859.

7th June.—Assistant.—Leaving lighthouse from 9 a.m. until midnight on one occasion, and continually absenting himself from the station to work as a carpenter at a neighbouring farm house, and his disrespectful behaviour when spoken to on the subject by principal keeper.

Severely reprimanded, and threatened with removal to a rock station on a suitable opportunity.

19th July.—Principal and assistant keeper.—Coming on shore for the day once a month without asking leave of the agent beforehand.

Both were informed that they had incurred the displeasure of the Elder Brethren, and the surprise of the Board was expressed to the assistant that the caution given him on a former occasion should not have been attended with a better result.

30th August.—Principal keeper.—Charged by assistant with being asleep in the house during his turn to keep watch, the light in the lantern nearly out, and with using threatening and abusive language on the assistant awaking him.

Having admitted being absent from his post during his watch, he was reduced to rank of assistant, and removed to another station.

8th September.—Assistant keeper.—That the foregoing charges were brought by him against the principal keeper from private and malicious reasons.

Removed to another station.

17th November.—Assistant keeper.—Complaint by master gunner of neighbouring fort of his proceedings in depriving him of certain perquisites, and causing bad feeling on the part of the military towards himself (the master gunner).

Cautioned as to his future proceedings.

15th December.—Assistant keeper.—Having been seen in a state of intoxication when on shore.

Being called upon for explanation of his conduct, he forwarded a petition, stating, that if his offence were overlooked in this instance, he would never again be guilty of similar misconduct; whereupon he was re-instated in his position with a severe reprimand and caution.

1860.

26th April.—Principal and assistant keeper.—Gross neglect of duty and want of cleanliness of the establishment (reported by an inspecting committee).

Expression of Board's extreme displeasure conveyed to both.

Principal cautioned that if reports of future Committees do not show that a decided improvement has taken place he will be removed to a station where he will be under more immediate supervision, and reduced to the rank of assistant keeper during pleasure.

Assistant cautioned and informed he will be expected to use his best exertions in placing the establishment on a footing in regard of cleanliness with the other lighthouses of the corporation.

8th May.—Assistant keeper.—Commanding officer of neighbouring garrison reported the conduct of the assistant keeper in stabbing one of the corporals in the mouth when under the influence of liquor, and in subsequently giving him a severe blow in the eye which knocked him down, and also for taking his men out of barracks at night on a previous occasion contrary to orders, which had been reported to the principal keeper.

Assistant was at once dismissed the service, and the principal severely reprimanded for not having reported the first offence of the assistant.

21st June.—Principal and assistant keeper.—An officer of Royal Artillery preferred a complaint against one of the keepers for demanding a fee of 1s. for showing the lighthouse.

Explanation having been required of principal keeper, and the same being unsatisfactory, both keepers were severely reprimanded, and a notice of the circumstance, and the occasion of it, sent to each establishment, with a caution that any keeper demanding payment for showing the lighthouses will render himself liable to dismissal from the service.

7th August.—Principal and assistant keeper.—Continued and systematic neglect, the visiting committee having found that this light is the solitary exception to the high state of efficiency in which all the other stations were found.

Trinity House convictions of servants.

*Trinity House
convictions of
servants.*

Principal cautioned that unless improvement take place he will be removed and reduced to rank of assistant during pleasure.

Assistant reprimanded and removed to another station.
23rd October.—Principal keeper.—Disagreements with assistant keepers and boatmen, occasioned in some measure as agent states, by the disposition of keeper's wife and her dislike to the place.

Cautioned that any further complaint being made of his conduct, or that of his wife, he will be disgraced and removed, and also reminded of his having been under the Board's displeasure when stationed elsewhere.

Lightvessel Service.

1854.

14th February.—Carpenter.—Having on two occasions absented himself for several days without leave, and not making his appearance until after the relief had left.

Dismissed the service.

25th April.—Crew of a lightvessel.—Refusing to relieve the keeper of the spare lightvessel when on shore.

Ordered to take their turn in spare lightvessel, as customary, and acquainted that any one refusing will be immediately dismissed the service.

9th May.—Two of the same crew.—Refusing to obey the order to relieve the ship-keeper.

Dismissed the service.

23rd May.—Six of the same crew.—Refusing to obey the order to relieve the ship-keeper.

Dismissed the service.

20th June.—Seaman.—Drunkenness and abusive language.

Dismissed the service.

25th July and 8th August.—Four seamen.—Fighting on board the lightvessel.

One dismissed, the other three removed to the most outlying stations.

*28th November.—Seaman.—Having heard of the death of his wife in London, quitted his vessel to see her buried without obtaining leave of the officer in charge.

Reprimanded for so absenting himself, but under the circumstances retained in the service.

*31st August.—Master carpenter, two lamplighters, two seamen.—Found by visiting committee asleep in their hammocks and off watch, about mid-day.

Removed to outlying stations.

5th December.—Two seamen.—No signal shown on the "Irene" passing, that the steamer was observed before her boat had been lowered down, the accused having the watch at the time.

Both fined one week's pay for their neglect.

1855.

12th April.—Lamplighter.—Complaint by mate of his insubordinate conduct when proceeding out with the relief, and of his being occasionally given to acts of intemperance when on shore.

Dismissed the service.

27th September.—Seaman.—Misconduct and insubordination reported by master of lightvessel.

Superintendent having stated that he is a good working hand, has been several years in the service, and is not given to drink, and that no previous complaint has been made against him, he was retained in the service with a reprimand and caution.

1856.

8th January.—Lamplighter.—Insubordinate and violent conduct when in a state of intoxication, on board the lightvessel (reported by the master).

Discharged from the service.

12th February.—Seaman.—Improper language and conduct towards master of the lightvessel.

Having been ordered to attend the Committee, and declining to so he was discharged.

6th May.—Seaman.—Complaint by mate and crew of lightvessel, of insubordinate and unbecoming conduct.

Period of service of accused being adverted to he was exchanged into another lightvessel, and cautioned that on any renewed complaint he would be dismissed.

17 June.—Seaman.—Having been informed by agent (when on duty in the tender) of the hour of sailing, he did not come on board at time appointed, and had been on shore drinking.

Having previously committed himself in the same manner he was discharged from the service.

14 August.—Masters or officers in charge and those of the crews on duty, on board three lightvessels.—Reported by committee for not keeping watch on the morning of 26th July 1856.

Officers and men reprimanded for not keeping a better look out. Superintendent directed to caution the officers and crew of every lightvessel that similar instances of neglect on the part of those who may have the watch will not be overlooked in future.

1857.

10 November.—Seaman.—Having absented himself on several occasions without leave, and not proceeding on board with the relief.

Dismissed the service.

1859.

6 January.—Seaman and Carpenter.—Dispute between them while a shipwrecked crew were on board the lightvessel, in the course of which the language they used towards each other was stated to be the most disgraceful.

These statements having been considered, the seaman was put back two steps in his promotion, and removed to another lightvessel. The carpenter was continued in the original vessel, and both were severely reprimanded.

22 March.—Seaman.—Having altered the date of his certificate of birth for the purpose of bringing himself within the regulation in regard to the age of persons eligible for appointment to the service.

Correct date being ascertained he was discharged.

7 April.—Seaman.—Insubordination in refusing to remain on board the lightvessel the third month in his turn, in consequence of another of the crew having been rendered unfit for duty by accident.

Dismissed the service.

12 July.—Seaman.—Reported by superintendent for having appropriated a piece of plank, the property of a builder at work on the wharf.

Suspended from duty, but the owner of the wood having stated that he considers it was taken through mistake, the seaman was reprimanded and cautioned to be more circumspect, and re-instated.

13 December.—Four seamen.—Complaint by mate of insubordination and neglect of duty when on board the lightvessel.

Charges having been investigated by committee, two of the four men who were then on shore were dismissed at once; the other two as soon as they could conveniently be landed.

1860.

29 March.—Two seamen.—Complaint by master of the disobedience of his orders.

Both were dismissed the service.

8 May.—Two seamen.—Report by mate of a fight between them.

Both reprimanded, one removed to another lightvessel.

19 July.—Two seamen.—Accused of taking old stores and selling them.

Prosecuted at the assizes, and acquitted for want of evidence; subsequently discharged from the service.

11 December.—Two seamen.—Report by master of steamer that he had the signal displayed for the boat from the lightvessel to come to him for 20 minutes, but that it was not observed until the steamer was nearing the light.

Explanation required of master of lightvessel, and the accused who had the watch at the time were severely reprimanded, and cautioned against the repetition of a similar neglect of duty.

27 December.—Carpenter.—Taking away from the lightvessel, on his coming ashore and quitting the service, certain tools the property of the corporation.

Articles having been recovered, accused was allowed to go free after a suitable admonition, agent having stated that he seemed much impressed by his situation and the impropriety of his conduct.

1861.

10 January.—Seaman.—Reported by the mate to have disobeyed his orders, and used abusive language.

Reprimanded for his conduct, and removed to another vessel.

Number of men in lighthouse service	-	156
„ in lightvessel service	-	391

Total	-	547
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Trinity House.
31st January 1861.

OBSERVATIONS OF THE DEPUTY MASTER OF THE TRINITY HOUSE ON THE RELIEFS AND EXPENSE OF KEEPERS' DWELLINGS AT SCILLY.

Royal Commission, Lights, Buoys, and Beacons,
7, Millbank Street, S.W., London.
DEAR ADMIRAL GORDON, 23rd February 1861.

I BEG to forward extracts from a letter addressed to me as Chairman of this Commission. They include the expression of certain views regarding Lighthouse management, accompanied by something like strictures on particular points of that management.

You would greatly oblige me if you will obtain for me in general terms, and as concisely as practicable, the observations of the Elder Brethren on the accompanying remarks. Some of them I can quite anticipate, but on one or two points, such as the undue expense of the residences of the Bishops Lightkeeper, and how those residences came to be fixed at St. Mary's instead of St. Agnes, I can, of course, only be enlightened by the Elder Brethren.

As the writer of the letter from which I send extracts has every claim to attention, I have thought it right to furnish you with his remarks; and I should be very glad if as early a reply to them as the business of the Elder Brethren would enable you to furnish me with.

Believe me,
Yours very truly,
W. A. B. HAMILTON.

Rear Admiral Robt. Gordon.

Trinity House, 4th March 1861.

DEAR ADMIRAL HAMILTON,

WITH reference to the questions contained in your letter of the 23rd December, it will perhaps be sufficient if I say that the system of *distinct classes* for lighthouse keepers, and the crews of light vessels, is the result of long practical experience with lightvessels on all parts of the coasts of England, and that "mental and physical inferiority" in their crews has never yet been apparent to the Elder Brethren.

The "Seven Stones" Lightvessel is within signal distance of St. Martin's Head, near Trescow, where the Agent

resides, and where the cutter is stationed. The crew of the "Seven Stones" also live there in readiness for any emergency. *Keepers' dwellings cost.*

It requires seamen and men of some nerve to be useful in the event of the vessel breaking adrift in one of those gales to which she is exposed.

Applications for removal always receive due consideration. The men themselves are quite satisfied with the arrangements as to the reliefs.

The regulations for promotion ensure the utmost fairness to all employed in the service.

The junior keeper at St. Agnes was sent there after 12 months probation (with others) at the wharf at Blackwall. I cannot learn that there was any particular reason for sending him to St. Agnes.

The regulations now in force would place the recipient of a first appointment in a Rock Lighthouse.

The dwellings for the keepers of the Bishop Rock Lighthouse were built at St. Mary's, because we have no spare ground at St. Agnes, and because difficulties were overcome by obtaining ground from the Government on favourable terms. The cost of these dwellings is considerably more than those built at "Senan Cove" for the Longships Lightkeepers. The former, 2,100*l.* (including 1,100 feet of stone boundary), and they are in every respect perfect in their construction and accommodation, and are likely to be durable for many years to come; whereas the Longships dwellings were built by local contract for 1,374*l.* 8*s.* 3*d.*, in order to meet the views of the Board of Trade in respect of economy.

They are already constantly requiring repairs, and will, I fear, prove in the long run very costly.

I am not aware of having overlooked any material point, but I shall be ready to give any further explanation you may require.

Believe me,
Yours very truly,
ROBT. GORDON.

Rear Admiral Hamilton.

CIRCULAR XIII.

THE FOLLOWING CIRCULAR LETTER WAS SENT TO THE OWNERS OF STEAMBOATS WHICH PASS WHITBY LIGHTS.

SIR,

I HAVE to request that you will be pleased to desire the Masters of Steamers belonging to your Company, who are in the habit of passing the Whitby Lights, to make observations on the present appearance of those Lights, in the following form; as a change has been made in one of the Lights, and the Royal Commission are anxious to ascertain the effect of the alteration.

Royal Commission, Lights, Buoys, and Beacons,
7, Millbank Street, S.W., London.

I am, Sir,
Your obedient Servant,
(Signed) J. F. CAMPBELL, Secretary.

RETURN from _____, Captain _____ trading between _____ and _____
of the appearance of the Whitby Lights.

Date.	Time.	Weather.	Compass Bearing of Lights.	Estimated Distance.	South Light.	Comparison. { much brighter than, rather brighter than as bright as rather less bright than much less bright than }	North Light.
<i>Specimen.</i> 1860. Dec. 11th	10 P.M.	- -	S.W. $\frac{1}{2}$ S.	About 15 M.	South much brighter than north.		
Dec. 15th	2 A.M.	- -	S.S.W.	About 3 M.	South much less bright than north.		

NOTE.—It is requested that this Return may be sent by post, unpaid, to the address on the back of the page, without fail, by December 25th, or earlier, if six observations on different nights have been made,

Whitby Lights. RETURN from the "Wansbeck," Captain Thomas Butcher, trading between London and Newcastle, of the appearance of the Whitby Lights.

*Evidence of
Mariners.
Circular XIII.*

Date.	Time.	Weather.	Compass Bearing of Lights.	Estimated Distance.	South Light.	Comparison, { much brighter than rather brighter than as bright as rather less bright than much less bright than }	North Light.
1860.							
Dec. 10th	6 P.M.	Fine but dark.	N.W.	4 M.		South much brighter than north.	
" 12th	8 P.M.	Fine starlight.	S.S.W.	10 M.		South brighter than north.	
" 17th	9 30 P.M.	Cloudy weather.	N.W.	11 M.		South brighter than north.	
"	11 P.M.	"	W.	4 M.		North as bright as south.	

GENTLEMEN,—My personal remark is that the south is brighter than the north; as on several times I have passed remarks on the difference of the two lights.

I am, Gentlemen,

THOMAS BUTCHER.

RETURN from the "Earl of Aberdeen" Steamer, Captain Thos. Howling, trading between Aberdeen and London, of the appearance of the Whitby Lights.

Date.	Time.	Weather.	Compass Bearing of Lights.	Estimated Distance.	South Light.	Comparison, { much brighter than rather brighter than as bright as rather less bright than much less bright than }	North Light.
1860.							
Dec. 13th	5 P.M.	Clear.	N.W.	About 13 M.		South rather brighter than north.	
" "	6 15 P.M.	"	W.	About 8 M.		South as bright as north.	
" "	7 20 P.M.	Cloudy.	S.W. $\frac{1}{2}$ S.	About 12 M.		South as bright as north.	
Dec. 20th	4 50 P.M.	Clear.	S.W. $\frac{1}{2}$ W.	About 14 M.		South as bright as north.	
" "	5 30 P.M.	"	W. by N.	About 6 M.		South as bright as north.	
" "	7 0 P.M.	"	N.W. by N.	About 12 M.		South as bright as north.	

GENTLEMEN,—I was careful in observing those lights on all bearings between N.W. and S.S.W., and could not observe any difference in them. I consider them to be splendid bright and clear lights.

Your's respectfully,

THOS. HOWLING, Master.

RETURN from the "Neptune" Steamer, Captain William Elliott, trading between Hull and Newcastle, of the appearance of the Whitby Lights.

Date.	Time.	Weather.	Compass Bearing of Lights.	Estimated Distance.	South Light.	Comparison, { much brighter than rather brighter than as bright as rather less bright than much less bright than }	North Light.
1860.							
Dec. 2d	4 A.M.	Hazy.	W.N.W.	About 8 M.		South rather brighter than north.	
Dec. 8th	6 P.M.	"	S. by W.	About 6 M.		South rather brighter than north.	
Dec. 13th	7 P.M.	Clear.	N.W.	About 12 M.		South much brighter than north.	
Dec. 13th	8 30 P.M.	"	W.	About 5 M.		South much brighter than north.	
" "	9 45 P.M.	"	S.W. $\frac{1}{2}$ S.	About 10 M.		South rather brighter than north.	
Dec. 16th	5 15 P.M.	"	N.W. by N. $\frac{1}{2}$ N.	About 10 M.		South much brighter than north.	
Dec. 23rd	11 30 P.M.	"	N.W. by N.	About 12 M.		South much brighter than north.	
Dec. 24th	2 0 A.M.	"	W. by S.	About 7 M.		South rather brighter than north.	
" "	3 30 A.M.	"	S.W. by S. $\frac{1}{2}$ S.	About 14 M.		South rather brighter than north.	

RETURN from the "Countess of Lonsdale," Captain W. Phillips, trading between London and Edinburgh, of the appearance of the Whitby Lights.

Date.	Time.	Weather.	Compass Bearing of Lights.	Estimated Distance.	South Light.	Comparison, { much brighter than rather brighter than as bright as rather less bright than much less bright than }	North Light.
1860.							
Dec. 11th	{ 6 P.M. till 9 P.M.	Cloudy.	W.N.W. to S. by S.	{ From 3 to about 12 miles.		South light as bright as north light.	
Dec. 16th	{ 6 30 P.M. till extinguished.	Clear.	S.S.W. to W.S.W.	{ From about 15 miles to 3 miles.		South light as bright as the north light.	

It may not be impertinent to add, that having been requested to pay particular attention to the appearance of Whitby lights myself I, without making such known to officers and passengers, called their attention to them, requesting them to tell me which of the two they considered the brighter light, when all agreed with me that both were good, and one no less bright than the other. W.P.

RETURN from the "Aberdeenshire," Captain Wm. Talbot, trading between Aberdeen and Hull, of the appearance of the Whitby Lights.

Date.	Time.	Weather.	Compass Bearing of Lights.	Estimated Distance.	South Light.	Comparison, { much brighter than rather brighter than as bright as rather less bright than much less bright than }	North Light.
1860.							
Dec. 12th	5 $\frac{1}{2}$ P.M.	Clear.	S.W. by W.	18 M.		South rather brighter than north.	

RETURN from the "Brilliant," Captain Gardner, trading between Leith and Hull, of the appearance of the Whitby Lights.

Date.	Time.	Weather.	Compass Bearing of Lights.	Estimated Distance.	South Light.	Comparison, { much brighter than rather brighter than as bright as rather less bright than much less bright than }	North Light.
1860.							
Dec. 13th	6 A.M.	Clear.	W.	About 8 M.		Both alike bright.	
Dec. 19th	4 A.M.	"	S.W.	"		Do. do.	
"	6 A.M.	"	W. by N.	About 10 M.		South much less brighter than north.	
Dec. 25th	3 A.M.	"	W. by S.	About 8 M.		South not much less brighter than north. (sic.)	
1861.							
Jan. 5th	10 P.M.	"	W. by N.	About 10 M.		South much less brighter than north.	
"	11 A.M.	"	W.	About 8 M.		Both alike bright.	
"	12 P.M.	"	S.S.W.	About 16 M.		South light not visible, north clear.	

*Summary of
this Evidence.*

This circular was intended to test practically the result of the changes which had been made at the instance of the Commission in the setting of the apparatus, &c., and in the lamp at South Whitby. See accounts of these proceedings (*ante*). These observations agree generally with those made by the Commission after the change, in that the south light showed much brighter than the north at short distances, and brighter generally. The difficulty of comparing two distant lights of nearly equal power, even placed side by side, is very great, and requires practice or some instrument to assist the eye. The result, however, was not so favourable as had been anticipated, and it was thought desirable to try to discover a reason. See papers which follow.

CONSUMPTION OF OIL AT WHITBY.

Whitby Lights.

SIR,
Trinity House, London, E.C.,
23d October 1860.
I am directed to acknowledge receipt of your letter dated 20th instant, relative to the consumption of oil at the Whitby Lighthouses, and in reply, I am to transmit to you the accompanying return.

J. F. Campbell, Esq.,
&c. &c.

I have, &c.
P. H. BERTON.

CONSUMPTION OF OIL at the NORTH WHITBY Lighthouse on the undermentioned nights.

October, 1860.	Time of Lighting.		Time of ex- tinguishing the Light.		Oil consumed.				
	Hrs.	Min.	Hrs.	Min.	Gals.	Qts.	Pints.	1 Pts.	Gills.
5th.	5	31	6	8	1	2 1/2	1	—	1
6th.	5	28	6	10	1	2 1/2	1	—	1
7th.	5	26	6	11	1	2 1/2	1	—	1
8th.	5	22	6	13	1	2 1/2	1	—	1
9th.	5	22	6	15	1	2 1/2	1	—	1
10th.	5	19	6	16	1	3	—	—	—
11th.	5	15	6	18	1	3	—	—	—
12th.	5	13	6	20	1	3	1	—	1
13th.	5	11	6	21	1	3	—	—	—
14th.	5	8	6	25	1	3	—	—	1
15th.	5	6	6	25	1	3	—	—	1
16th.	5	4	6	26	1	3	—	—	—
17th.	5	2	6	28	1	3	—	—	1

CONSUMPTION OF OIL at the SOUTH WHITBY Lighthouse on the undermentioned nights

October, 1860.	Time of Lighting.		Time of ex- tinguishing the Light.		Oil consumed.				
	Hrs.	Min.	Hrs.	Min.	Gals.	Qts.	Pints.	1 Pts.	Gills.
5th.	5	31	6	8	2	—	—	—	—
6th.	5	28	6	10	2	—	—	—	—
7th.	5	26	6	11	2	—	—	—	—
8th.	5	22	6	13	2	—	—	—	—
9th.	5	22	6	15	2	—	—	—	—
10th.	5	19	6	16	2	—	—	—	—
11th.	5	15	6	18	2	—	—	—	—
12th.	5	13	6	20	2	—	—	—	—
13th.	5	11	6	21	2	—	—	—	—
14th.	5	8	6	25	2	—	—	—	—
15th.	5	6	6	25	2	—	—	—	—
16th.	5	4	6	26	2	—	1	1	—
17th.	5	2	6	28	2	—	1	—	—

P. H. BERTON,
Secretary.

Trinity House, London, E.C.,
23d October 1860.

Returns were subsequently sent of the consumption of oil at the North and South Whitby lighthouses during the month of December, from which it appeared that the total quantity consumed was

North—71 gallons, 3 quarts, 1 1/2 pint, 1 gill.
South—71 do. 3 do. 1 do.

In consequence a letter was written to which the following is a reply:—

Trinity House, London, E.C.,
February 14, 1861.

SIR, I AM directed to acknowledge receipt of your letter, dated 31st ultimo, with reference to the returns called for by the Royal Commission on Lights, as to the consumption of oil at the Whitby Lighthouses in December and January last, and expressing the great surprise of the Commissioners that the consumption (for the month of December) is 71 gallons, 3 quarts, 1 pint, and 71 gallons, 3 quarts, 1 pint, 1 half pint respectively, and inquiring whether any, and if any, what instructions were given to the keeper of the South Light as to the maintenance of a high flame after the recent change in the lamp; and whether any, and if any, what notice has been taken of the circumstance of the consumption of oil in the mechanical lamp being identical or almost so with the consumption in the North Lighthouse; and in reply I am to state, for the information of the Commissioners, that Mr. James Chance, in his report to Professor Faraday, dated 17th November last (with a copy of which the Commissioners have been furnished), informed that gentleman that he has at present provided the South Lighthouse temporarily with two good mechanical 4-wick lamps, but that he proposes sending ultimately two pressure 4-wick lamps, which he prefers; and that, pending the completion of this arrangement and the result of the experiments with pressure lamps still under consideration at the Trinity House, the Elder Brethren have not deemed it necessary to give the keeper at the South Lighthouse any specific instructions beyond that of keeping up a good flame, nor to take any special notice of the consumption being equal in the two lamps for the month of December.

I am further to observe, that in Mr. Faraday's Report, dated 19th October last, the proportion of consumption between the two lights was stated to be 15 pints for the South Light to 13 for the North Light, and that the oil bills for the entire month of January, copies of which are now enclosed, show a proportion nearly similar, viz., 77 gallons against 70 gallons, 1 quart, 1 pint.

J. F. Campbell, Esq.,
&c. &c.

I have, &c.,
P. H. BERTON.

From this it appears that the advantage of the new lamp was lost by burning a small quantity of oil, and that the advantage gained was due solely to the setting of the apparatus. See ante accounts of visits to Whitby, and several papers on Whitby.

Summary of
this Evidence.

ADMIRALTY CO-OPERATION.

ADMIRALTY CO-OPERATION IN PREPARING LISTS OF LIGHTS, NOTICES TO MARINERS, CORRECTIONS IN CHARTS, &c.

Royal Commission,
Lights, Buoys, and Beacons,
7, Millbank Street, S.W., London,
December 15th, 1860.

SIR, WITH reference to a letter from the Board of Trade to the Admiralty, dated 8th December, 1854, in reply to one from the Admiralty, dated 6th December, to the Board of Trade, the Commissioners would be obliged if you will inform them,—

(1) Whether the Official Lists of Lighthouses published by the Admiralty is dependent for its accuracy, as regards the United Kingdom and Colonies, on the "full record" which the Board of Trade, in the above letter, says will "be kept in their office of all lights in the Queen's dominions," and if so, in what shape, and at what periodical intervals, the alterations of old lights, the erection of new lights, &c., are communicated to the Board of Admiralty by the Board of Trade; and if not, then upon what information, whence obtained, &c., is the official list that is pub-

lished by the Board of Admiralty, as far as regards above-named lights, formed and corrected.

(2) I am further directed to inquire, with reference to the latter portion of the same paragraph, 7, of the above-named letter, whether the Officers of Her Majesty's Navy have special orders to "report to the Admiralty upon the efficiency of the several lights," and to request that a copy of any order or circular to that effect, that may have been addressed to the Officers of the Navy, may be sent to the Commissioners.

(3) I am further directed to inquire whether the above reports have been "communicated to the Board of Trade with a view to their registration by that Board."

(4) I am directed to request that you will permit the Commissioners to see the original reports from the Officers of Her Majesty's Navy that have been received since the date of that letter, 8th December, 1854.

For the convenience of their Lordships, I am directed to enclose a printed copy of the correspondence above referred to.

I am, &c.,

J. F. CAMPBELL,
Secretary.

The Secretary, Admiralty.

Admiralty.

SIR, Admiralty, February 1, 1861.
 WITH reference to your letter of the 15th December, requesting information on the subject of lighthouses in the United Kingdom and Colonies, I am commanded by my Lords Commissioners of the Admiralty to acquaint you that the subject has been referred to their Lordships' hydrographer, a copy of whose report is inclosed herewith, for the information of the Royal Commission on Lights, Buoys, and Beacons.

J. F. Campbell, Esq.,
 &c. &c.

I am, &c.,
 W. PENNELL,
 Pro Secretary.

IN accordance with the Board Minute, to report in reply to the queries respecting the Admiralty Lists of Lights, &c. contained in the letter of the Royal Commission on Lights, Buoys, and Beacons, dated the 13th December last, I have to submit the following statement:—

I. The Admiralty list of lights is now, and has been for the last few years, in a great measure dependent for its accuracy, as regards the lights of the United Kingdom and Colonies, on the record kept by the Board of Trade. On every occasion of reprinting the Admiralty List (generally once a year), the proof sheets are sent to that Board, who take the trouble to examine them carefully, and correct any error which they may discover.

II. It is not at any "periodical interval," but immediately on an alteration taking place in any existing light, home or colonial, or on the exhibition of any new light, that the Board of Trade (or in case of a home light, the Trinity Board) at once communicates the fact, with all particulars, to the Admiralty, who forthwith issue a printed notice to mariners (a copy of which is enclosed), and distribute from 750 to 1000 copies of it, as the case may be. And with respect to the "shape" in which the information is communicated by the Board of Trade, no time is lost by them in copying it, but the original document is transmitted or rather brought to the Hydrographic Office of the Admiralty, so that not an hour should be lost in making it public.

III. The Admiralty Lights List, as already mentioned, is mainly dependent for information respecting home lights on the Board of Trade and the Trinity House, and for colonial lights on the Board of Trade alone; but in addition the Admiralty gets information direct through its own surveying officers by special correspondence, and not unfrequently from colonial newspapers; for, notwithstanding the Board of Trade letters to the Colonial Office of 15th August, 1855, and 28th July, 1856, requesting that information might be sent, and the Colonial Office Instructions to the Governors of the respective colonies thereupon, some of the colonies are remiss in sending home the required information, or send it tardily; and if the Admiralty did not get it from the sources specified, we sometimes should not get it till very late, or perhaps not at all.

IV. No special order or circular to report on lights beyond the general printed instructions has been issued to the navy. It would be the duty of a captain to report to his commander in chief anything wrong in a light that he might observe, but if the light was apparently in good order he would not notice it. In the General Naval Instructions now under revision, their Lordships have directed that the captain shall cause each light on passing to be compared with the official list; and if found not to be correct it is to be immediately reported. In some special cases lights have been reported on by naval officers, as the Cerigo light by Captain Spratt, at the request of the Board of Trade, and a copy of the report was sent to that Board. Surveying officers have general orders to report upon the lights on their respective stations, and this they frequently do in their correspondence with the hydrographer.

Reports on lights, however, require to be received with great caution. Some training is necessary to watch lights with accuracy. Flashing lights will frequently be reported as Revolving lights, and vice versa, and the intervals of flash or revolution, which must be carefully reckoned by seconds, are often given very vaguely. The French or general continental character of a "Fixed and Flashing" light is frequently mis-stated. No one who has not had some experience in lights would believe the erroneous statements occasionally reported officially. As an illustration I may mention the case which has just occurred of the Port Said Light, on the coast of Egypt. First, then, this light, which is only 25 miles from Alexandria, had been exhibited some months before anything was known of it in Europe, or at any rate in England, until I accidentally visited the spot

and saw it in October last. 2ndly, upon inquiry being made through the proper channels, this light was officially reported as *revolving*, showing alternately a *red* and *green* light. Knowing, fortunately, from my own inspection that such was not the fact, I wrote to Alexandria to institute further inquiries, and only a few days since it was again officially reported and proved to be a *fixed white* light (as I knew it to be), and as such it is inserted in the Admiralty charts and lights lists.

V. Having replied to the queries of the Royal Commission on Lights, with respect to home and colonial lights, it may not be irrelevant if I go into some little detail as to the Admiralty lists of lights in general, the means available to keep them correct, the steps taken to make public any new light or alteration in an old light, and the course pursued to ensure its insertion in all the Admiralty charts that it may affect.

1st. The existing lights, as far as we are aware, home, colonial, and foreign, amount to about 2,290 in number; and the Admiralty list and description of them is contained in ten pamphlets, divided according to the respective naval stations. It is the special duty of the 3rd naval assistant in the hydrographic office to keep these lists complete by every means in his power. At the request of the Admiralty some years since the Foreign Office issued a circular to all British Consuls, to report any alteration of lights or any exhibition of a new light in their several districts. By these means, by correspondence with all colonial and foreign lighthouse Boards, and by searching in foreign periodicals, as the *Moniteur de la Flotte* for France, the *Morskoi Sbornik* for Russia, and others, we endeavour to keep the list correct; but even these sources frequently fail us; only yesterday, a Russian officer called at the hydrographic office, and told me that two new lights in the Black Sea would be exhibited in the course of the spring, one at Sikhum Kaleh, and the other at Eupatoria, in the Crimea, whereas we had never heard even that lighthouses were building at these places; and not a week ago I learnt for the first time that a light existed at Mandavi in the Gulf of Kutch (only 300 miles N.W. of Bombay), which, as far as I am aware, has never appeared or any Indian or European chart, or list of lights hitherto published.

2ndly. The steps taken to make public the exhibition of a new light.

Immediately on the receipt of information of an alteration of any consequence in an old light, or the placing of a new light, a "Notice to Mariners" (such as enclosed) is prepared in the hydrographic office by the 4th naval assistant, whose special duty it is to do so. When a proof of it has been carefully examined and approved by the hydrographer, from 750 to 1,000 copies of it are printed and widely distributed. Of these, 150 copies are sent to the Custom House in London, one copy to be exhibited at each Custom House throughout the United Kingdom, 70 copies to the Board of Trade, 10 copies each to the Trinity Houses of London, Leith, Dublin, Newcastle, and Hull; to Lloyds', to the *London Gazette*, the *Shipping Gazette*, to the Chambers of Commerce at Liverpool, Glasgow, &c.; to all Foreign Consuls; to the Governor of the Colony it may affect; to the naval commanders in chief for each ship in their respective squadrons; to the various depôts of charts at the outposts, as Portsmouth, Plymouth, Cork, Gibraltar, Malta, Cape of Good Hope, &c.; and to the principal agent and sub-agents for the sale of Admiralty charts throughout the country. And in order to facilitate the correction being made, the number and title of each cart that it affects is printed on the face of the notice.

Enclosed is a copy of the notices issued during the present year, and of the list of Boards and individuals to whom distributed. Four Notices to Mariners. One List.

Lastly.—The course pursued in order to ensure the insertion of a new light in all the Admiralty charts which it may affect.

As soon as a notice is received it goes to the assistant hydrographer, or chief draughtsman, to insert the new light or correction on the chart, and so to the engraver, and if not a very extensive correction, it is the duty of the junior draughtsman to insert by hand the correction in all the charts on the shelves of the hydrographic office. The notices, as before mentioned, are widely distributed and sent to all Commanders-in-Chief, to place in the chart boxes in depôt, and to all agents for the sale of charts, who are required either to insert the correction in the chart, or to supply a copy of the printed notices along with every copy of any chart affected by it that they may sell. If an extensive correction is necessary, the former edition of the chart is cancelled; the agent for the sale of charts has in that case a standing order to return all the copies he has in hand to the Hydrographic Office (where they are torn into eight pieces to prevent their getting into circulation

Notice to
 Mariners.

again*), and copies of the new edition supplied free of cost. Hydrographic notices, such as enclosed, are treated in the same way. When a chart is corrected for a new light, &c., the chief draughtsman sends it to the 3rd naval assistant, for examination: if correct, he signs his initials to it as a guarantee for its accuracy, before it is brought to the hydrographer, for his final examination and *imprimatur*.

The enclosed printed label, shows the ordeal that a chart has to pass through before being issued to H.M. ships, and to the public. I am not aware of any other check that can be desired, or I would willingly take advantage of it.

(Signed) J. WASHINGTON,
Hydrographer.

28th January, 1861.

From MALBY AND SONS.

First print, No. Is it ready for press?
Is Mr. Potter to have notice that this chart is corrected?
Is this edition to supersede those at the office?
Is this edition to supersede those in the chart boxes?
Capt. Becher for general examination.
Comd. Dunsterville for lights and notice.
Mr. Burdwood for tides.
Mr. Evans for variation.
Plate received from Messrs Walker.

Hydrographic Notice.—No. 5.

AUSTRALIA.—EAST COAST.—OUTER ROUTE.

The following are the results of the recent exploring cruise of H.M.S. "Herald," Captain Denham, in the Coral sea, Australia, between the months of January and June, 1860.

Passage.—The passage from Port Jackson to the southern confine of the Coral Sea in the month of January was commenced under a north wind and a southerly current, in the full confidence, from former experience, that on making an offing of 150 miles to the eastward a north-easterly set would be found, and the skirt of the south-east trade attained; anticipations which were duly realized, and placed the ship at the Mellish reef on the tenth day.

Mellish Reef.—Found the skeleton triangular beacon which we had erected here in September, 1859, from the debris of the French steamer "Duroc," still standing, but made quite white by birds, which prevents its being so easily seen.† It is 32 feet above the mean level of the sea, and should be visible from the deck of a ship eight miles. Verified former positions of the reef in $17^{\circ} 24' 39''$ S., and $155^{\circ} 52' 45''$ E., and re-rated chronometers. (The drawing is omitted.)

Lihou Reefs.—Crossed the Outer route to the westward, to resume the examination of the Lihou chain of reefs and cays from where the "Herald" tracked it to in 1859, and by now determining its northern elbow in $17^{\circ} 10' 30''$ S., $152^{\circ} 12' 20''$ E., it became evident that it was identical with the Alert reef, which had been reported as a distinct reef, but which might now be expunged from the charts. The Diana reef may likewise be expunged; it could not be traced after most diligent search.

The Willis Group consists of two grassy islets elevated 33 feet, and a low sand cay spreading 10 miles North and South. The cay and its reef form the northern extreme of the group, and hence a salient feature upon the western side of the Outer route in $16^{\circ} 7' 5''$ S., $150^{\circ} 3' 8''$ E. The magnetic variation here is $7^{\circ} 11' 1''$ E., and the tide hour 8 o'clock, with a rise and fall of 6 feet. Abundance of turtle will be found here, as well as upon the Lihou cays at this season (February), and a shelf of anchorage soundings will be found upon the western aspect of this group but no soundings along its eastern face.

Coringa Cays.—The north-eastern of the two Coringa islets proved to be in $16^{\circ} 55' 52''$ S., $149^{\circ} 12' 56''$ E.; they are grassy, and elevated 23 feet, situated $3\frac{1}{2}$ miles apart, upon the bearing of S. $53^{\circ} 30'$ W.

The Madelaine Cay, with its belt reef, is in $16^{\circ} 30' 17''$ S., long., $150^{\circ} 17' 12''$ E., a grassy islet, of 23 feet elevation lies 5½ miles S. 30° E. A 25 fathom shelf of soundings spreads 4 miles off the western face of this group, but no soundings offer upon its north-eastern aspect. The Coringa and Madelaine dangers may be considered as guarded from the Outer route by Willis group.

No Bougainville reef could be traced anywhere between the parallels of $16^{\circ} 20'$ and $14^{\circ} 40'$ S., within the meridians

$147^{\circ} 10'$ and $148^{\circ} 50'$ E. If Bougainville has been quoted a degree wrong in latitude, the Holmes reef of 1851 may be what he saw, at all events his position presents no reef.

Osprey Reef, the next and only boundary danger between Willis group and Raine island entrance to Torres Strait, was found to be of triangular form, subtending five-mile sides, its margins awash, with its most protruding elbow regarding the Outer route navigation, situated in $13^{\circ} 51' 5''$, $146^{\circ} 35' 20''$ E.; the magnetic variation $6^{\circ} 23'$ E., and a tide hour of 8h. $36\frac{1}{2}$ m., with a rise and fall of 6 feet. No soundings at a ship's length around this reef.

The Raine Island sea-mark was duly sighted upon a N.W. by W. course from Osprey, after a 200 mile run, a course which was not affected by any current though passing through fields of drift wood. A smooth water anchorage was taken up round the Great detached barrier reef, 7 miles S. by W. $\frac{3}{4}$ W. from Raine island, whence the necessary visits were made to the island to rate chronometers, to land supplies of provisions* for distressed voyagers, and to inspect the state of the sea-mark, the dome of which had become decayed and fallen in, but as it still presents a substantial tower it needs no restoration until it shall become a lighthouse, which the now determined Outer route question suggests.† (The drawing is omitted.)

The chief part of the 13 days' detention at this anchorage (March 21st to April 3rd) arose from the calms which preceded the eastern monsoon, but as soon as a working breeze sprang up the narrows were easily cleared upon an ebb tide, and Mellish reef regained in a 26 days' beat against the S.E. trade.

Passage.—From Mellish reef, with fresh chronometric data, and under (at this season) the unvarying south-easter, a passage was made to Sandy Cape vicinity upon the port tack, felching through between Sir James Saumarez reef and "Herald's" extreme of the Great Barrier reef, and thence, by courting the southerly set, which runs at $1\frac{1}{2}$ knots along the east coast of Australia, at a 25 mile offing, Port Jackson was regained under a continued beat against the southerly wind, in 15 days from Mellish reef demonstrating that a sailing ship can effect the Coral Sea passage in 41 days from Torres Strait to these colonies, after the western monsoon has ceased at the Strait to help her on her first stage to the eastward.

Outer Route.—This cruise of the "Herald," in connexion with her previous examination of the Coral Sea, goes to show that a clear route of 150 miles wide, free from current, with five positively defined dangers on the eastern hand and six upon the western, is now open to vessels bound to India from any of our Australian, Tasmanian, or New Zealand colonies, by simply taking up a point of departure in 24° South, intersected by the meridian 157° East, and then steering the following courses:—

N. by W $\frac{3}{4}$ W.	240 miles to lat. 20° 0 S.
N.W. $\frac{1}{2}$ W.	700 " " 11 36 " (the parallel of Raine island).
W. $\frac{1}{2}$ S.	220 " " to Raine island (upon its parallel).
On the East Side the boundary dangers are,—	
Bellona	- 21 52 22 S. † 159 25 30 E. Var. 9 30 E.
Breaker	- 21 26 36 " 158 46 " " 9 19 "
Booby	- 20 57 0 " 158 31 53 " " "
Mellish	- 17 24 39 " 155 52 45 " " 8 30 "

On the West Side the boundary dangers are,—	
Cato	- 23 15 32 S. 155 37 20 E. Var. 9 23 E.
Wreck	- 22 10 30 " 155 28 41 " 9 43 "
Kenn	- 21 15 24 " 155 50 35 " 9 0 "
Lihou	- 17 10 30 " 152 12 20 " 8 3 "
Willis	- 16 7 0 " 150 2 59 " 7 11 "
Osprey	- 13 51 0 " 146 35 20 " 6 23 "

* The following provisions were landed from H.M.S. "Herald's" stores on the 26th March 1860:—Biscuits 750lbs., Chocolate 104 lbs., Pork 320 lbs., Flour 210 lbs., Preserved Meat 48 lbs., Rice 20 lbs., Pickles 6 bottles, Candles 6 lbs., Water 2 casks.

† The Raine island sea-mark was erected in the year 1844 by the crews of H.M. ships "Fly" and "Bramble," Captain Francis Blackwood, R.N., assisted by the Government of New South Wales. It is now 60 feet high, and should be visible 8 miles clear weather.

‡ The longitudes of these positions have been adapted to the meridian of Fort Macquarie, Sydney, assumed to be in $151^{\circ} 14'$ East of Greenwich, as all the Admiralty charts are graduated to that position. The recent observations of the Astronomer at Sydney place Fort Macquarie in $151^{\circ} 13' 33''$. Captain Denham uses $151^{\circ} 14' 40''$; but as said before, all the longitudes in the present and former Hydrographic Notices are in accordance with the Admiralty charts.

* Formerly cancelled charts were returned to the Stationery Office upon, they were sold as waste paper, and after a short time they were found in circulation again as Admiralty Charts; to obviate the possibility of such an occurrence every large chart is now torn into at least eight pieces, before it leaves the Stationery Office.

† As this beacon is only a temporary erection, the mariner is cautioned that it is uncertain how long it may remain standing.

Admiralty

The above courses are by compass, and the positions apply to the most salient features of the several reefs in regard to the Outer route fairway, a route now available for sailing ships to or from India, according to the monsoons, and at all seasons for steamers, which would thus shorten the passage between Sydney and Singapore by one-fourth, in smooth water, and hence in smaller vessels than are now employed to face the Indian Ocean round by Cape Leeuwin.

It is understood that Captain Denham's suggestion of forthwith establishing a fixed white light upon the Kenn reef and upon Ruine island has met with the favourable attention of his Excellency Sir William Denison, the Governor-General of Australia and its dependencies.

Hydrographic Office, Admiralty, London,
12th August, 1860.

This Notice affects the following Admiralty Charts and Sailing Directions:—General Chart of Australia, No. 1,042; Index Chart of N.E. coast of Australia, No. 2,385; General Chart of Indian Ocean, No. 2,483; Sheets 5 and 6 of Pacific Ocean, Nos. 2,463, 2,464; Hydrographic Notice No. 4, Australia, East Coast; and Chap. 7, Australia Directory, vol. 2.

Hydrographic Notice.—No. 6.

AUSTRALIA.

TORRES STRAIT.

Campbell Reef.—The ship "Storm Cloud," in a recent passage through Torres Strait by the Great N.E. channel, when running from the Ninepin rock to Wednesday island, passed about three cables' length from a reef, which appeared to be a very narrow ridge trending in a N.E. and S.W. direction, and about half a mile in extent.*

The reef is nearly in line between the easternmost and highest Double Island and Mount Ernest Island, distant about $5\frac{1}{2}$ miles from the former and $6\frac{1}{2}$ miles from the latter island.

Caution.—As this newly discovered danger is in the route occasionally used by vessels bound through the Prince of Wales Channel from the eastward, and has hitherto escaped the vigilance of surveying officers, and as its exact position is yet uncertain, the utmost caution is required in using this passage.

The prompt attention of the commander of the "Storm Cloud" in reporting this danger to the Lords of the Admiralty, is acknowledged by their Lordships naming it after the discoverer.

EAST COAST.—OUTER ROUTE.

On the East Side boundary dangers, the position of Booby reef is stated in Hydrographic Notice No. 5, to be in long. $158^{\circ} 19' 23''$ E.; it should be $158^{\circ} 31' 53''$ E. Bampton Reef (omitted) south-west end is in lat. $19^{\circ} 52' 22''$ S. and long. $158^{\circ} 19' 23''$ E.

Hydrographic Office, Admiralty, London,
4th October 1860.

NOTICE TO MARINERS.

No. 1.

MEDITERRANEAN.—COAST OF EGYPT.

FIXED LIGHT AT PORT SAÏD.

Information has been received at the Admiralty, that a light has recently been exhibited from a lighthouse at Port Saïd, 29 miles S.E. of the Damietta mouth of the Nile, coast of Egypt.

The light is a *fixed white* light, placed at an elevation of 66 feet above the main level of the sea, and should be seen from the deck of a ship at a distance of 9 miles in clear weather.

The illuminating apparatus is dioptric or by lenses, of the third order.

The lighthouse is a skeleton tower of wood, and stands in lat. $31^{\circ} 16' 0''$ N., long. $32^{\circ} 19' 30''$ East from Greenwich.

[The Bearings are magnetic. Variation $6^{\circ} 10'$ West in 1861.]

By Command of their Lordships,
JOHN WASHINGTON,
Hydrographer.

Hydrographic Office, Admiralty, London,
24 January 1861.

This Notice affects the following Admiralty Charts:—Mediterranean General, No. 2158; scale, $d=1.1$ in.; Mediterranean General, No. 2718^c; Coast of Egypt, No. 2573. Also Mediterranean Lights List, No. 324^a, May 1860.

* See Admiralty Chart, Torres Strait, Western Channels, No. scale $d=30$ inches, on which this danger is marked.

NOTICE TO MARINERS.

No. 2.

BALTIC.—GULF OF FINLAND.

ALTERATION OF LIGHTS AT KRONSTAT.

The Imperial Ministry of Marine in Russia has given Notice, that the following alterations will be made in the lights at Kronstat, prior to the opening of the navigation in the spring of 1861:—

The three *fixed* lights in the centre of the Fort of Emperor Paul I. or Rishank Fort, will be discontinued.

The eastern light on Nicholas battery at Kronstat, which is now 45 feet above the mean level of the sea, will be raised 58 feet above the same level, and should be visible from the deck of a ship in clear weather at a distance of 12 miles.

The western light, which is now 21 feet above the mean level of the sea, will be raised 23 feet. This increase of height will make no alteration in the horizontal arc through which the light will be visible.

WERKO MATALA BEACON OFF BIÖRKÖ.

Also, that a red beacon has been placed on the south-east side of the Werko Matala or bank, near the entrance of Biörkö Sound; with the tower on Pitko-nemi or point W.S.W. $\frac{1}{2}$ S. and the north-east point of Biörkö N.W. northerly.

The white beacon on the eastern part of the bank will be removed.

[The bearings are magnetic. Variation at Biörkö, $6^{\circ} 20'$ West in 1861.]

By Command of their Lordships,

JOHN WASHINGTON,

Hydrographer.

Hydrographic Office, Admiralty, London,

11th January 1861.

This Notice affects the following Admiralty Charts:—Baltic Sea, No. 2362; Baltic, Sheet 7, No. 2192; St. Petersburg Bay, No. 2279; Kronstat, No. 2215; Kronstat to St. Petersburg, No. 2215a. Also Russian Lights List, No. 190 and 191.

NOTICE TO MARINERS.

(No 3.)

BALTIC.—GULF OF FINLAND.

NEW BEACONS IN THE GULF OF RIGA.

The Imperial Ministry of Marine in Russia has given notice that the following beacons have been erected in the Gulf of Riga:—

Two new mast beacons have been placed to show the direction of the channel into Riga. These beacons are surmounted by a triangle with the apex upwards, and a small barrel placed horizontally above. They stand respectively 85 and 87 feet high, and 478 yards apart, in a direction N.W. by W. $\frac{1}{2}$ W. The N.W. beacon is higher, and its base larger than that of the S.E. beacon. They can be seen from a distance of 10 miles.

Also, that the lower light at Riga has been turned 30° to the westward, so as to be seen from N. $\frac{1}{2}$ W. to N.W. $\frac{1}{2}$ W.

And that the following beacons will be placed prior to the opening of the navigation in 1861:—

On the south side of the banks of Kuno S.W. $\frac{1}{2}$ S. $6\frac{1}{2}$ miles of the church of St. Nicholas, a red broom turned downwards.

At 34 miles to the southward of the extremity of the Sorkholm reef, a red broom turned downwards.

On the coast of Lïvonia on a 9-feet shoal, which lies S.W. by W. 2 miles in advance of the cape Taker-ort, a black broom turned downwards.

On an 11-feet shoal, W. by N. $\frac{1}{4}$ N. 4 miles of the village of Kahlukula, a double broom red above and white below.

On a 17-feet bank, which lies N.W. by N. $3\frac{1}{4}$ miles of the farm of Ainensch, a white broom placed upright.

On the extremity of the reef which extends off the entrance of the river Att Salis, about $6\frac{1}{2}$ miles from the beach, in a depth of 26 feet, a double broom white above and red below.

[The bearings are Magnetic. Variation at Riga $8^{\circ} 15'$ West in 1861.]

By Command of their Lordships,

JOHN WASHINGTON,

Hydrographer.

Hydrographic Office, Admiralty, London,
17th January 1861.

This notice affects the following Admiralty Charts:—Gulf of Riga, Nos. 2,194 and 2373; Entrance to the Gulf of Riga, No. 2,263; Mouth of River Dwina to Riga, No. 2,256. And Russian Lights List, No. 165.

NOTICE TO MARINERS.

(No. 4.)

MEDITERRANEAN—ADRIATIC.

FIXED LIGHT ON THE PEDAGNE ROCKS BRINDISI.

The Department of Public Works at Naples has given Notice, that on and after the 31st day of January 1861, a light will be exhibited from a lighthouse erected on the north-western of the Pedagne rocks at the entrance of Brindisi harbour.

The light is a *fixed white* light, varied by a flash once every three minutes; the flash is preceded and followed by a short eclipse. The elevations of the light is 72 feet above the mean level of the sea, and it should be seen in clear weather from the deck of a ship, at a distance of 13 miles.

The illuminating apparatus is dioptric or by lenses of the fifth order.

The tower is a column rising from a small circular building 36 feet high and coloured white. Its position is given as lat. $40^{\circ} 39\frac{1}{4}'$ N., long. $17^{\circ} 59' 32''$ E. or 2 miles westward of the longitude in the Admiralty Charts.

REVOLVING LIGHT ON POINT TORRE DI PENNE.

Also, that a light will be exhibited from a lighthouse erected on point Torre di Penne, near Brindisi, on the south-east coast of Italy.

The light is a revolving *white* light, attaining its greatest brilliancy every half minute; the elevation of the light is 129 feet above the mean level of the sea, and should be seen in clear weather from the deck of a ship, at a distance of 20 miles.

The illuminating apparatus is dioptric or by lenses of the third order.

The tower is circular, 82 feet high, and coloured white; and at the foot of it is a rectangular building. Its position is given as lat. $40^{\circ} 41' 05''$ N., long. $17^{\circ} 56' 18''$ East of Greenwich, or 3 miles westward of the longitude in the Admiralty Charts.

By Command of their Lordships,
JOHN WASHINGTON,
Hydrographer.
Hydrographic Department, Admiralty, London,
18th January 1861.

This Notice will affect the following Admiralty Charts:—Italy, South-east Coast, Sheet 5, No. 198; Brindisi Harbour, No. 1492; Mediterranean General, Nos. 2158 and 2718; Adriatic General, No. 1440; and Adriatic, Sheet 6, No. 205. Also Mediterranean Lights List, Nos. 198 and 202.

LIST OF BOARDS AND INDIVIDUALS to whom NOTICES of LIGHTS are furnished by the Admiralty.

Commanders in Chief, Home Stations.

Copies.

- 5. Woolwica.
- 5. Chatham.
- 5. Sheerness.
- 15. Portsmouth.
- 15. Devonport.
- 5. Pembroke.
- 5. Queenstown.

Commanders in Chief or Senior Officers', Foreign Stations.

- 0. Baltic.
- 40. Mediterranean.
- 10. Lisbon.
- 20. West Coast of Africa.
- 10. Cape of Good Hope.
- 50. East Indies, China.
- 10. Australia, Sydney.
- 15. Pacific.
- 10. Brazils.
- 10. West Indies.
- 15. North America.

Governors of the Colonies.

- 5. Of those notices which apply to their own Government.

Master Attendants.

- 10.* Portsmouth.
- 10.* Devonport.
- 6.* Sheerness.
- 6.* Pembroke.

London.

- 150. Custom House.
- 70. Board of Trade.

Copies.

- 80.* Coast Guard.
- 20. Lloyd's.
- 10. Trinity House.
- 1. London Gazette.
- 1. Shipping Gazette.
- 5. Potter J. D., 31, Poultry, E.C.
- 5. Potter, D., 11 King Street, Tower Hill.
- 5. Stanford, Charing Cross.
- 1. Malby and Son, 27, Parker Street.
- 1. Nautical Magazine.
- 1. Mercantile Marine Magazine, 30, Trinity Square, Tower Hill.
- 1. Wilkins and Co., 24 Long Acre.
- 2. Chance & Co., Birmingham.

Liverpool.

- 5. Chamber of Commerce.
- 3. Mercantile Marine Association.
- 3. Underwriters Room.
- 3. B. J. Thompson, Esq., 20, Water Street.
- 5. J. C. Johnstone, Custom House Agent.
- 5. Jewitt and Co., South John Street, Agent.
- 5. Phillip and Son, South Castle Street, Agent.
- 5. Walker, South Castle Street, Agent.
- 5. Newcastle, Trinity House.
- 5. R. Thompson, 40, Quay Side, Agent.
- 5. Sunderland, Reid and Co., High Street, Agents.
- 10. Hull, Trinity Board.—R. C. Appleby, Custom House Agent.
- 5. Bristol, Chamber of Commerce.
- 5. Hill and Price, Broad Quay, Agents.
- 5. Cardiff, Williams, But, Docks, Agent.
- 5. Edinburgh, Commissioners of Northern Lights.
- 5. Do., Chamber of Commerce.
- 5. Leith, Trinity House.
- 5. Reid and Son, 36, Shone, Agents.
- 5. Dundee, Seamen's Fraternity.
- 5. Glasgow, Chamber of Commerce.
- 5. McGregor, 8, William Street, Agent.
- 5. Greenock, McGregor, 8, William Street, Agent.
- 3.* Oban.—Commander Bedford, R.N.
- 10. Dublin, Ballast Office.
- 5. Hodges and Smith, 104, Grafton Street, Agents.
- 5. Belfast, Chamber of Commerce.
- 10. Cork, Committee of Merchants.
- 5. Hugh Cale, Queens Town, Agent.
- 5. Waterford, Chamber of Commerce.

Foreign Hydrographers.

- | | |
|-----------------------|----------------------|
| 2. Paris, Dépôt de la | 2. Stockholm. |
| 2. Marine. | 2. Copenhagen. |
| 2. Madrid. | 2. Christiania. |
| 2. The Hague. | 2. U. S. Washington. |
| 2. St. Petersburg. | |

Foreign Consuls.

- | | |
|------------------------|---|
| 6. France. | 2. Haiti. |
| 2. Spain. | 2. Grenada. |
| 2. Portugal. | 2. Venezuela. |
| 2. Sardinia. | 2. Brazils. |
| 2. Two Sicilies. | 6. Argentine Confederation. |
| 2. Tuscany. | 2. Uruguay. |
| 2. Austria. | 2. Chile. |
| 2. Greece. | 2. Bolivia. |
| 2. Turkey. | 2. Peru. |
| 2. Belgium. | 2. Jacob Swart, Amsterdam. |
| 2. Netherlands. | 2. Messrs. Blunt, New York. |
| 2. Denmark. | 2. Superintendent Coast Survey, New York. |
| 2. Sweden and Norway. | 2. Lighthouse Board, Washington. |
| 6. Hanseatic Republic. | |
| 8. Prussia. | |
| 2. Russia. | |
| 6. United States. | |
| 2. Mexico. | |

Foreign Agents for the Sale of Charts.

- | | |
|--------------------------|-------------------------------|
| 5. Malta. | 5. Buenos Ayres. |
| 5. Cape of Good Hope. | 5. Halifax, Nova Scotia. |
| 5. Algoa Bay. | 5. Picton. |
| 5. Melbourne, Australia. | 5. North Sydney. |
| 5. Adelaide. | 5. Charlestown, P. E. Island. |
| 5. New Zealand. | 5. Gulf of Canso. |
| 5. Auckland. | 5. Mirimachi. |
| 5. Port Cooper. | |
| 5. Wellington. | |

* Only the Home Lights.

BUOYAGE.

Buoysage system. SCHEME proposed for general adoption by Commander BEDFORD, of the Admiralty Survey, Oban. The large charts showing the application of the system in the mouths of the Thames have been placed together with the drawings collected by the Commission.

Admiralty Survey, Oban.
From Mull, July 29th, 1859.

MY DEAR SIR,

AFTER I had parted from you in the Sound of Mull I felt that my visit had been too short, and I feared I had not made myself clearly understood upon the several points submitted to me. I have illustrated the two propositions, one made by yourself, the other by Captain Ryder, upon the proposal for uniformity of buoying.

The arrangement is local, and I believe will be considered to offer no difficulties.

I have written to the Hydrographer for charts of the mouths of the Thames, to which I will direct my attention immediately on receipt. I should feel much obliged if you would kindly give me a rough limit of time for sending it in, as I should of course not wish to jeopardise, by a hurried consideration, a system which, if carried out, will be of so much benefit to navigation.

I beg to enclose dates of several letters referring to lights and buoys. Those of a prior date I will also send when I return to head quarters.

I have, &c.
E. J. BEDFORD.

Rear-Admiral W. A. B. Hamilton,
&c., &c., &c.

DATES AND ADDRESSES OF LETTERS relating to LIGHTS, BUOYS, AND BEACONS, between July 1857 and 1859.

Date.	Address.	Subject.
Nov. 12, 1857	Secretary of the Admiralty.	Proposition for uniformity of buoying.
" 17 "	Editor of Nautical Magazine.	Ditto.
" 21 "	Ditto ditto	Lights on this coast generally, printed inaccurately.
" 26 "	Ditto ditto	Islay Light showing over Oronsay (did not appear in print).
Mar. 24, 1858	Secretary, Northern Lighthouse Commissioners.	Buoys of the Tay.
April 2, "	Ditto - - -	Ditto, Sound of Mull.
" 7, "	Ditto - - -	Ditto, general district proposition.
" 17, "	Ditto - - -	Ditto, ditto, Yarmouth Road (illustrated).
" 20, "	Secretary, Admiralty.	Referring to Lord C. Paget's Motion in the House of Commons.
Oct. 28, "	Hydrographer as Commissioner of Harbour of Refuge.	Islay Light showing over Oronsay.
Nov. 4, "	Ditto - - -	Ditto.
" 13, "	Secretary of Admiralty.	Ditto.
" 25, "	Ditto - - -	Buchanness and Kinnaird Lights.
Dec. 18, "	Ditto - - -	Islay Light.
May 6, 1859	Secretary, Royal Commission on Lights, &c.	General questions answered.
" 10, "	Ditto - - -	Surveyor's experience not recognized.
" 18, "	Ditto - - -	Dubb Hertach, Islay Sound Lights, &c.

SECOND LIST OF DATES AND ADDRESSES OF LETTERS relating to LIGHTS, BUOYS, AND BEACONS.

Date.	Address.	General Subject.
Mar. 29, 1854	Hydrographer -	Improvements proposed for the navigation of Islay Sound.
June 20, "	Ditto - - -	Objections to the proposed Islay Light.
Aug. 12, "	Ditto - - -	On the Board of Trade's decision respecting the site for Islay Lighthouse, argument against.
Oct. 11, "	Secretary, Northern Lighthouse Commissioners.	Ditto.
Dec. 4, "	Ditto - - -	Loss of "Chevalier," and its bearing on Islay Lighthouse.
June 25, 1855	Hydrographer -	Remonstrance against the limit proposed by the Board of Trade for the Islay light.
Jan. 24, 1856	Messrs. Stevenson	On Dubh Hertach and general neglect of the navigation of the Sounds of Jura, &c.
April 14, "	Secretary, Admiralty.	On the lighting of the west coast of Scotland, Isy Sound particularly.
May 24, "	Ditto - - -	Reply to Sir Archibald Campbell, Bart., M.P., on his observations relating to Islay Light.
May 26, "	Sir Arch. Campbell, Bart.	On the dangerous effects likely to be produced from the proposed limits of Islay Light; also proposition for other lights, including Dubh Hertach.
June 7, "	Ditto - - -	Lighting the west coast of Scotland generally.
Feb. 2, 1857	Secretary, Northern Lights.	Neglect of Jura Sound.
" "	Hydrographer -	Ditto.
" "	Secretary, Northern Lighthouses.	Lighting of the west coast of Scotland (south).
" 9, "	Ditto - - -	Tobermory Light, extension of green light.
Mar. 12, "	Secretary, Trinity House.	Lighting Sound of Jura, &c.
Jan. 12, 1856	Hydrographer -	Relates, with other matter, to the wreck of another steamer, and the neglected state of the navigation.
Feb. 3, 1854	Secretary, Northern Lights.	On uniformity of buoying.

E. J. BEDFORD, Commander.

Copy.

DEAR SIR,
19th August, 1859.
THERE is one expression in your letter of the 13th received yesterday, which I forgot to refer to, and which I think of value; viz., where you allude to the want of the faculty in some persons to distinguish one colour from another. I had no idea till I had to give some attention to it, how many there are more or less deficient in that faculty; and it is a misfortune, I fear, that the red is the colour most frequently uncertain in its power of impression. Where a red light, for instance, has shown a brilliant and most marked colour to my vision, some of my companions have scarcely recognized the shade.





*The Scheme fully Illustrated on
two Charts of the Thames submitted
to the Commissioners by*

E. Bedford
July 20. 1859.

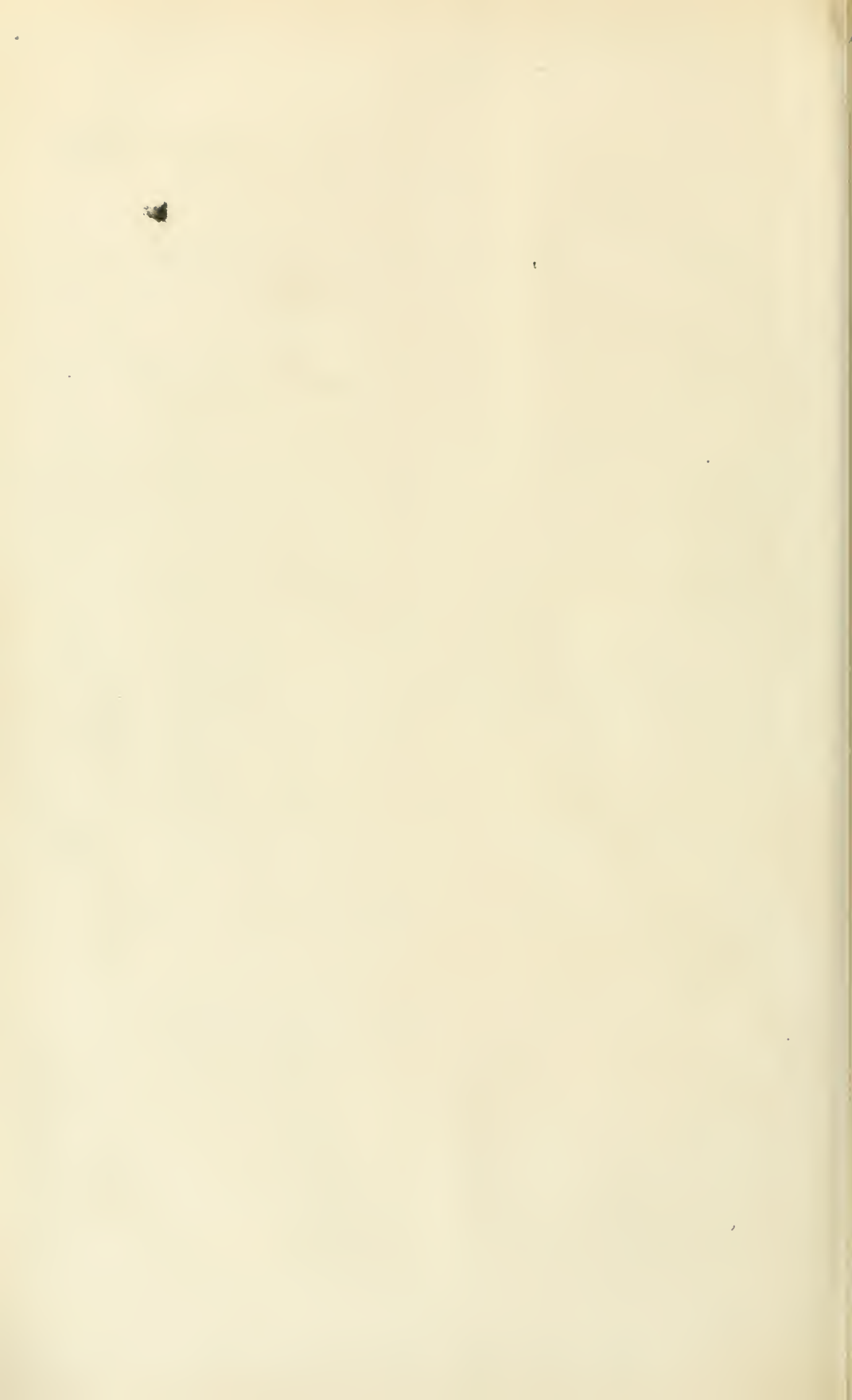
July 20. 1859.



All Locks or other waters having no natural sea going outlet are to be buoyed in accordance with Harbour arrangements the boundaries to which are here indicated in Red

The general Fairway to be considered as in the district of Glasgow and buoyed as if proceeding to  or sailing from  that place

W. H. Bedford
Mar 7 1840



It is a serious question, to say the least of it, and one that will have to be gone into with care some day. In the meanwhile, as far as my own senses go, red and black would seem to be the best colours generally for buoys; I was more struck with this in the Channel leading to the port of Dublin than anywhere, the buoys being fresher coloured.

I am not prepared to advocate the chequered plan. After all, it is but an exaggeration of the Shepherd's plaid, which is about the most invisible of mixtures.

I am, &c.,
W. A. R. HAMILTON,
Rear-Admiral.

Commander E. J. Bedford, R.N.

DEAR SIR,
I BEG to submit to the consideration of the Royal Commissioners a tracing of part of the West Coast of Scotland to illustrate the principle of district arrangement proposed for adoption in carrying out the uniform system of buoying and beaconing.

I am, &c.,
E. J. BEDFORD,
Commissioner.

The Chairman, Royal Commission on Lights,
&c. &c. &c.

DEAR SIR,
I BEG to enclose a second list of dates, &c. of communications relating to lights and buoys. Referring to the proposition for uniformity in the latter, I do not recommend the colours as far an arbitrary adoption, for I think experiments should be made under the various aspects of distance, light, and shade, and a decision founded thereon, issued for general guidance. Nothing can be more variable than the opinions entertained by different parties upon the subject, whilst there are some who do not possess the faculty for distinguishing one colour from the other. I instance

the following cases, illustrating difference of opinion:—At Hartlepool *white* is preferred to *red*, as being supposed to be more readily distinguished; whilst Captain Sullivan, I believe, considers *white* nearly *useless* for the purpose; he thinks *chequered* better than *red*. Mr. Stevenson, on the contrary, objects to the *former*, giving preference to the one *decided* colour. Captain Sullivan mentions two cases where neither *black* or *red* could be distinguished one from the other, and yet in Liverpool (a tolerable good and practical test), requiring 83 buoys to mark its dangerous approaches, *red* and *black* have been the favourite arrangement for 25 years. No doubt, if black is permitted to become *rusty*, and the *red* be of too dark a shade, errors under certain lights may arise, but they will be errors from neglect not from colour.

I am, &c.
E. J. BEDFORD,
Commissioner.

Admiral W. B. Hamilton,
&c. &c. &c.

DEAR SIR,
In your letter of the 19th instant you refer to the buoying of Dublin River as a favourable example of the adoption of the plain colours red and black, but you perhaps have also observed that they are placed just the reverse from what they are in the opposite and more important port of Liverpool, and it would be no difficult matter to illustrate the disadvantage and probable injury that might result therefrom.

From plans before me I find at Cork both black buoys and red ones are placed on the starboard hand; *white* on the port.

At Wexford black—white and red are used apparently without any order whatever.

I am, &c.
Admiral W. A. B. Hamilton,
&c. &c. &c. E. J. BEDFORD.

CIRCULAR XIV.

QUESTIONS FOR CAPTAINS OF STEAMERS FREQUENTING THE PORT OF BOULOGNE.

The Commissioners appointed by the Queen to inquire into the condition and management of Lights, Buoys, and Beacons, namely, WILLIAM ALEXANDER BAILLIE HAMILTON, Esq., Rear-Admiral, R.N.; ALFRED PHILLIPS RYDER, Esq., Captain, R.N.; JOHN HALL GLADSTONE, Esq.; DENCAN DENBAR, Esq., Chairman of the London Local Marine Board; and SAMUEL ROBERT GRAVES, Esq., Chairman of the Liverpool Local Marine Board; by virtue of the authority vested in them by Royal Warrant, request that the accompanying Forms may be filled up with as little delay as possible, and that you will return them through the Post Office (*unpaid*).

J. F. CAMPBELL, Secretary.

7, Millbank Street, S.W., London,
November 26th, 1859.

1. What is your opinion as to the usefulness and efficiency of the bell now used as a fog signal at the extremity of the west pier at Boulogne? *Fog signal.*
2. In thick weather can you find your way into the port by the sound of the bell alone?
3. Can you hear it at sufficient distance for all practical purposes?
4. Have the goodness to give your name and the name of the vessel which you command?

1. My opinion is that a bell on Boulogne Pier is a great assistance in taking a vessel into the harbour in foggy weather, and that a larger bell than that now in use would be still more effective.

2. No; but in approaching the harbour the sound of the bell is valuable, in conjunction with the use of the lead, in ascertaining the position of the vessel.

3. A larger bell, which could be heard at a greater distance, would, in my opinion, be desirable, as ordinarily the present one can only be heard on approaching close to the pier.

4. George James Grant, Master of the "Rainbow."

December 1st, 1859.

SIR,

Steamship "Holland,"
December 1st, 1859.

My opinion as to the usefulness of the bell at East Pier of Ostend as a fog signal is, that it is as good as the gongs on board lightvessels, and has the same object in view, to acquaint vessels with the position they are in, and to prevent collision with the pier at tide time.

In thick weather I should say it was not possible to find the way into the port without some other guide, such as seeing some part of the pier on one side or the other, and I think it is not always possible to know exactly the point from which sound in foggy weather comes so as to advance towards it with confidence sufficient to enter a harbour across which the tide sets very strong.

The sound can be heard a good distance off; I cannot say how far.

I remember the "Triton" got on the east side of the pier in foggy weather, in the summer of 1851, from, I should say, not hearing the bell at sufficient distance, or not being able to tell in what direction the sound came.

I remain, Sir,

Your obedient Servant,
J. WATTS.

Martin Pratt, Esq.

*Fog signal.
Evidence Circular XIV.*

1. My opinion is that the sound of the bell is at all times a very great assistance in taking the harbour in foggy weather, but that the present bell is not sufficiently large for the purpose.

2. Yes, with the assistance of a well kept lead.

3. In my opinion no.

4. Samuel Wood; "Rhine."

1. The bell is useful, if near enough to hear it, as a guide in a fog and little surf on the shore to drill the sound of the bell.

2. I think not at the same time as the soundings are regular. The bell is very useful.

3. I think yes, as far as I have had experience to judge.

4. John Targett, Steamship "Seine," General Steam Navigation Company.

1. Having been but a short time on the Boulogne station, I have not had an opportunity of testing the usefulness of the bell, and I have not yet had a fog off the harbour to render that assistance necessary when entering.

4. Gilbert Scott Marshall, General Steam Navigation Company's Ship "Albion."

1. The bell on the West Pier Head is useful in indicating the position of the port.

2. If near enough to hear the bell there would be no difficulty in finding the pier, providing the weather be calm.

3. Yes, if the bell was larger there would be a greater difficulty in tracing the direction of the sound at the increased distance.

4. Henry Stranack, "Concordia," (S.)

1. The bell is exceedingly useful, and of great help when heard; but in my opinion a larger one is certainly required, as it is necessary to be very close to the pier heads to hear the one in present use.

2. Yes, with the assistance of a good lead.

3. In my opinion, no.

4. John William Reader, "Panther."

This bell is placed in the focus of a reflector, and the evidence goes to shew that it is not heard at any great distance. 2nd, that sound alone is an insufficient guide for direction. *Summary of Evidence.*

COAST LINE MEASUREMENTS.

FRANCE.

Measurement of Coast Line.

				Nautic Miles.
South Coast Mediterranean.	From Nice to C. Cerbere	Coast { Isles	448 89	537
West Coast.	From Funtarabia to Kersaint	Coast { Isles	1062 300	1362
North Coast	From Kersaint to Pass de Zuydcoote	Coast { Isles	798 66	864
			Total	2763

See Report, page v.

Coast Line of British Isles. ENGLAND.

				Nautic Miles.
East Coast.	Berwick to Dungeness	Coast { Isles	589 83	682
South Coast	Dungeness to Lands End	Coast { Isles	460 90	550
West Coast.	Lands End to Solway Firth	Coast { Isles	915 179	1085
" "	Isle of Man	" "	" "	88
				2405

SCOTLAND.

West Coast.	Annan (Solway Firth) to Cape Wrath	Coast { Isles	794 1028	1822
North Coast	Cape Wrath to Duncansby Head	Coast { Isles	1414 15	1563
East Coast.	Duncansby Head to Berwick	Coast { Isles	544 7	551½
	Hebrides Islands	" "	" "	600
	Orkney "	" "	" "	502
	Shetland "	" "	" "	837
				4469

IRELAND.

North coast	Farland Point to Fair Head	Coast { Isles	135 344	1604
East Coast.	Fair Head to Carnsore Point	Coast { Isles	307 84	316
South Coast	Carnsore Point to Dursey Island	Coast { Isles	440 92	532
West Coast.	Dursey Island to Farland Point	Coast { Isles	1104 339	1500½
				2518
	Total			3392

SUGGESTIONS FOR INSPECTIONS.

The following are some points which should be included in the Official Report of the Inspector of Lights, but will require to be completed:— *Capt. Ryder*

1. Name; date.

2. Nature of lamp and of illuminating apparatus (catoptric, dioptric, or catadioptric.)

3. Order; if catoptric, number of burners.

4. Character; (fixed, flashing, revolving); colour.

5. Cleanliness (carefully examine store room, lightroom, opening all doors, drawers, &c., state of paint).

6. Orderliness; note condition of store room; order with which stores are stowed away; look at account books.

7. Lightning conductor.

8. Fog signal, and need of one; do ships approach close when there is a fog?

9. Telegraph or signals; tide signals, and the need of them.

10. Water for drinking; filter.

11. When last inspected, and by whom.

12. Medicine chest.

13. Medical attendant; distance of; and how paid.

14. Situation; healthy or otherwise.

15. Nearest town; nearest Coast Guard station.

16. Wrecks; if any within twelve months.

17. Instruments; thermometer; barometer; clock dial; rain gauge.

18. Birds; fish; names; quantity.

19. Books; library, when changed.

20. Time for lighting; time for extinguishing; whether strictly adhered to.

21. Names of keepers; ages; period at this lighthouse; previous station; pay.

22. Oil; appearance; does it freeze in winter; is there a filter.

23. Tools; complete; in good order.

24. Hourly consumption of oil since last inspection.

25. Dwellings; how situated; accommodation; cleanliness; order; gardens and land; live stock.

26. Chimney; how many broken in last twelve months.

27. Ventilation; note appearance of inside of dome; whether smoky or otherwise.

28. Paint; when last painted inside and out.

SCIENTIFIC INSPECTION.

Requisites—String, foot rule, ivory scale, book pencil, small level and focus indicator.

1. Take off chimney glass and lower portion of metal tube; screw down wicks.

2. Note appearance of wick, if it has been cut down since the lamp was extinguished. If the overflow has been well maintained the wick ought not to be much charred.

3. Stretch two strings at right angles attaching them to the screws placed for the purpose. Note where intersection is. It ought to be in the centre of the centre wick, and touching burner. If not, note amount of error.

4. Place level on platform; note any deviation from level.

5. Then number the lenses and prisms, and looking through each; note by aid of the focus indicator where the

image of the sea horizon appears to cut or pass near the burner. To perform this with the greatest accuracy, if there is no focus indicator, a graduated card or ruler may be placed vertically on the burner's centre. This will answer for lenses and lower prisms. The portion of the image of the horizon as seen in upper prisms must be noted.

6. Note the character and quality of glass.

7. Note whether image of horizon as seen in lens, maintains a straight line, when the eye is raised and lowered, or whether it clings to the side of the glass.

8. At what distance outside the flame the foci are placed. The correct position for foci ought to be always registered at each lighthouse by the constructor, in a book that can be referred to by the inspector.

9. When the eye is constrained to look at prisms through a fixed point (the intended focus), note how the prism is divided between sea and water.

10. Note whether frame is diagonal or otherwise.

11. Note length of chimney (metal), where are first openings in metal chimney.

12. Note shoulder of glass chimney.

13. State of reflectors as to shape.

14. Light lamp; measure flame's height above burner when at its best.

15. Shift lamp, and time the operation.

16. If there is any metallic catoptric portion, note position and state of mirrors.

INSPECTION.

Nightly inspection by coast guard to be noted in Engineer's Register Report.

N.B.—Entrance by master key.

FORM OF REPORT.

1. Flame; condition of; bright or not; height by gauge.

2. Keeper on alert or not.

3. Oil in lamp, clean or not; reservoir, clean or not.

4. Lenses clean or not.

5. Lantern glasses, clean or not.

Form to be filled up and despatched once a week through controller of coast guard, or immediately, in case of any neglect on part of keeper.

FLOATING LIGHTS.

Depth of water, length of chain, nature of moorings, and when she last broke adrift, should be added to those of the above inquiry that are applicable to floating lights.

A. P. RYDER.

LAMP.

Royal Commission,
Lights, Buoys, and Beacons,
7, Millbank Street, S.W., London,
12th March 1861.

SIR,

In a letter to the Chairman of this Commission received from Mr. James Chance on the 8th instant, occur the following passages:—

"I have Captain Ryder's note concerning experiments with different lamps; and I will at once give orders about this very important matter."

"Until the points of the height of the flame and of the wick are settled, all other questions remain indeterminate."

"This is evident from the difference between the results as to the position of the most luminous section obtained at Edinburgh and Birmingham respectively."

"I infer from what Capt. Ryder says, that you purpose sending me a French pump lamp to complete the series."

The French lamp referred to is one that was sent over from the Calais Lighthouse to the Commission by M.

Reynaud, for the purpose of some comparative experiments. Proposed ex-
shat were then contemplated; subsequent events led them *perment on*
to consider it unnecessary that they themselves should *lamps*.

perform these experiments, though they always hoped that the question of the best description of lamp would receive a full and careful investigation.

The Commissioners now understand that the Elder Brethren are taking the matter into their consideration, and that Mr. Chance is desirous of deciding the points in question; they, therefore, beg to offer to the Elder Brethren the loan of the French lamp for the aforesaid purposes, and they doubt not that M. Reynaud, who was ready to send over a lightkeeper to attend to the lamp at any time that the Commissioners might desire, will, if requested, exhibit the same willingness to forward the purposes of the Trinity House.

I am, &c.

P. H. Berthon, Esq.

(Signed) J. F. CAMPBELL,
Secretary.

ADJUSTMENT OF APPARATUS.

The following correspondence with the Commissioners of Northern Lighthouses shows that previous to the investigations of the Light House Commissioners the engineers employed by the Scotch Board had not made any adjustment of the burners of dioptric lights with reference to the height of the light above the water:—

Royal Commission,
Lights, Buoys, and Beacons,
7, Millbank Street, London,
December 1, 1860.

SIR,

THE Commissioners have received a report from the Astronomer Royal of his visit to Girdleness; also a copy of Mr. Thomas Stevenson's report of that visit, as also of his (Mr. Stevenson's) visit to Whitby and the North Foreland. The Commissioners have also before them Mr. Thomas Stevenson's work on Lighthouse Illumination, 1859, second issue, and the replies he has been so good as to send to printed questions sent to him by them and also Mr. Alan Stevenson's Rudimentary Treatise, 1850. In the first of these works Mr. Thomas Stevenson speaks (p. 78, 79) of a "dipping light;" and he appears to think it suitable for high lighthouses, and in fogs, to direct the rays (ordinarily directed to the horizon) to points nearer at hand. He proposes that the apparatus should be hinged, and moveable under the control of the keepers. Mr. Alan Stevenson proposes (70, 124) that in very high lighthouses the "lenses should have a slight inclination outwards so as to cause the most brilliant portion of the emergent beam to reach the visible horizon which is due to the height of the lantern."

In p. 126 Mr. Alan Stevenson says, "In other cases, where the whole horizon has to be illuminated, and great vertical divergence is at the same time desirable, a slight elevation of the burner, at the expense, no doubt, of a small portion of light, is sometimes resorted to, and is found to

produce with good effect the requisite depression of the emergent rays."

The distance prescribed by Fresnel for the burner of a first order dioptric light to be placed below the focus for parallel horizontal rays is 28m. or 1·1 in. In a first order dioptric light placed at a height of 185 feet (Girdleness) the dip due to that height being 15' 37", and the tangent for the focal distance of that angle being 3·5m., the image of the horizon would be looked for and would be expected to appear at 28m. + 3·5m. = 31·5 m. or 1·23 in. above the burner.

The Astronomer Royal states that he found the image of the horizon 3·8ths inches too high (or at 1·6m) above the burner, and that he recommended the lamp to be raised half the error, or 3·16 in. The upper and lower prisms appeared to be well adjusted to the erroneous position of the lamp, and the Astronomer Royal recommended, therefore, that the lamps should only be raised 3·5 in., or one-half of its error. It would probably affect the adjustment of the upper and lower prisms if the lamp was to be accurately placed. It would appear, therefore, that the burner at Girdleness was lower even than Fresnel's position by 0·25m. (one quarter of an inch), and not higher, as it should have been, by 0·13 of an inch.

No conclusion, however, can be drawn from the experiments as to whether or not the lamp at Girdleness was originally adjusted to the visible horizon, because the burner appears from Mr. Stevenson's report to have been replaced without supervision.

Conversations with Mr. Thomas Stevenson have left an impression on the mind of the Commissioners (but they may be mistaken) that in no illuminating apparatus designed by him has he ever intentionally adjusted the lamp or apparatus to the height of the light above the water, or displaced the position of the lamp, as prescribed by Fresnel.

viz., the burner to be 1.1 in. below the focus for parallel horizontal rays in first-class dioptric lights.

The Commissioners desire to be informed, (1) what was the original position of the burner as regards the focus of the lens referred to in each of the first class dioptric lights erected by Messrs. A., Thos., and D. Stevenson, and by the late Mr. Stevenson in Scotland; and (2), further in detail, what course, if any, the Messrs. Stevenson adopt in adjusting the position of the lamp (with reference to the said focus) to the height of the light above the water, naming the lights in which this adjustment has been made, and its amount in each case; also (3) what course, if any, they adopt if they make the above adjustment, in making the further adjustments of the *lower* prisms, so that their said foci may not be in the metal burner when the lamp has been raised considerably in consequence of the light being a considerable height above the water, and also naming the lights in which the adjustment has been made; and also (4) what course they adopt in the above case in adjusting the *upper* prisms that their foci may not, when the lamp has been considerably raised, be in a different section of the flame from that previously selected by Fresnel, naming the lights in which the adjustment has been made; and also (5), whether in any case they have altered the position of a lens or prism after the illuminating apparatus has been erected at a lighthouse, and if so, in what cases and for what reasons; also (6) what precautions are taken when old burners are replaced by new burners, to ensure the correct position of the flame being accurately preserved.

I am, &c.

Northern Lighthouse Office,

SIR, Edinburgh, December 10, 1860.
I AM directed by the Commissioners of Northern Lighthouses to acknowledge receipt of your letter of 1st current transmitting various queries as to the practice of Messrs. Stevenson in regard to the lamps prepared by them. Having laid this before the Commissioners, they directed me to communicate it to Messrs. Stevenson, and I am now instructed to forward a copy of their answer.

I am, Sir,

Your most obedient servant,

ALEX. CUNNINGHAM,

The Secretary
Royal Commission on Lights, &c. Secretary.

Copy.

DEAR SIR, Edinburgh, 7th December 1860.

We have received the letter addressed to the Commissioners by the Royal Commission on Lighthouses, dated 1st December 1860, and we have, as requested by you, to make the following replies to the queries therein contained:—

1st Query. What was the original position of the burner as regards the focus of the lens referred to in each of the 1st class dioptric lights erected by Messrs. A. T. and D. Stevenson, and by the late Mr. Stevenson in Scotland?

Answer. In all of the lighthouses erected by Messrs. R. A. D. and T. Stevenson, the burner in 1st class dioptric

lights was originally placed in the position shown in the engraved diagram, which is hung up in the light rooms for regulating the position of burner and size of flame. In that diagram the top of the burner is $1\frac{1}{16}$ inch below the plane of the focus.

2d Query. Further in detail, what course, if any, the Messrs. Stevenson adopt in adjusting the position of the lamp (with reference to the said focus) to the height of the light above the water, naming the lights in which the adjustment has been made, and its amount in each case?

Answer. Messrs. Stevenson have not made any adjustment of the burner of dioptric lights with reference to the height of the lights above the water. The highest of the dioptric lights in Scotland is 346 feet, and it was not considered necessary in these cases to adopt any special adjustment. But the necessity for such an adjustment when the elevation was great was recognized by Mr. Alan Stevenson, in his "Treatise on Lighthouses," and was adopted by the late Mr. Robert Stevenson in the high catoptric lights, such as Barrahead, where the reflectors are dipped.

3d and 4th Queries. What course, if any, they adopt, if they make the above adjustment, in making the further adjustments of the *lower* prisms, so that their said foci may not be in the metal burner when the lamp has been raised considerably in consequence of the light being a considerable height above the water, naming the lights in which this adjustment has been made, and also (4) what course they adopt in the above case in adjusting the *upper* prisms, that their foci may not when the lamp has been considerably raised, be in a different section of the flame from that previously selected by Fresnel, naming the lights in which the adjustment has been made?

Answer. For the same reason no special adjustment has been made of the upper or lower prisms.

5th Query. Whether in any case they have altered the position of a lens or prism after the illuminating apparatus has been erected at a lighthouse, and, if so, in what cases and for what reasons?

Answer. No alteration has been made after the final adjustment of the light.

6th Query. What precautions are taken, when old burners are replaced by new burners, to ensure the correct position of the flame being accurately preserved?

Answer. The only precaution which is taken in renewing burners, is the employment of careful workmen, and the inspection of the foreman of lighthouse repairs, whose duty it is to see that the position of the burner is conformable to the engraved diagram.

In further explanation we have to state, that in all cases the apparatus is carefully inspected and tested before it leaves the workshop, and that before a new light is considered as finally adjusted in the light room and ready to be exhibited, observations are made upon it from the sea at various distances, and in various azimuths, when any imperfection that may be detected is rectified.

We are, &c.

(Signed) D. & T. STEVENSON.

A. Cunningham, Esq.,

Secretary, Northern Lights Board.

LATER OBSERVATIONS ON THE MAGNETO-ELECTRIC LIGHT AND STEAM FOG-SIGNALS.

Observations by Dr. Gladstone. Since the oral examination of Professor Holmes, I have visited his works at Northleeth. The electro-magnetic machine there is a smaller one than that used at the South Foreland Lighthouse, but the lamp is a great improvement on that previously employed. It appears to resemble in principle the lamp of M. Serin which he exhibited to me at Oxford last July. It seems simple in construction, and certainly gave a beautifully steady light, without the necessity of any attention. The only fluctuations in the intensity of the light were probably due to the presence of iron, or some other imperfection in the carbons. By means of the refracting goniometer I made a prismatic analysis of the light, and determined the following points, which have some bearing on lighthouse illumination:—

1st. The light presents a continuous spectrum, that is, it includes rays of every refrangibility, and that throughout a range exceeding the range of bright sunshine in England, both at the red or least refrangible and at the violet or most refrangible end. The character of the light closely resembles that of the sun, but with a larger proportion of violet.

2d. A thick sheet of Mr. Chance's red glass placed before the lamp was found to produce a beautiful red light. On analysis this was found to consist of a very large amount of red and orange rays, with a small quantity of green and blue.

3d. Sheets of green and blue-green glass from Mr. Chance's works gave rise to green and blue-green lights. Cobalt blue glass produced a purple light, with great reduction of the luminosity, and not so striking a modification of the colour as to render it advisable to employ it as a means of distinction. Cobalt glass also has this serious disadvantage for lighthouse purposes, that a bright light seen through it might be altered by a fog from purple to red.

4th. Much violet light of high refrangibility is emitted from the carbon points. As such light is known not to pass freely through glass, I particularly examined whether it formed so large a proportion of the rays as to render thick dioptric apparatus objectionable, and to incline the experimenter to turn his attention to apparatus arranged simply on the principle of reflection. I found, however, that the interposition of a piece of good plate glass about an inch thick, produced little sensible diminution of the light thrown on a sheet of white paper held at various distances. By special contrivances with the prism, however, I was able to determine that this glass did make a difference on the extreme violet rays, but so slight that it may fairly be disregarded. The light seen at the distance of a mile on a clear night still exhibited a violet ray, of a refrangibility scarcely known in sun light, notwithstanding the absorbent effect of the atmosphere on such rays.

The magneto-electric light is perfectly continuous, and not a rapid succession of sparks.

Professor Holmes exhibited it also in one of the large reflectors that he proposes for revolving lights. These as yet are somewhat roughly made, and their reflecting surface is tin-foil and not silver; but the ellipse and parabola are made with considerable approach to correctness, and the apparatus was fully capable of demonstrating practically that by this means Mr. Holmes is able to bring all the rays emitted from the carbon points on to a space subtending only a few degrees, and to cause very few rays to be sent to the sky, while the sea and the horizon are brilliantly illuminated. The whole apparatus revolving will cause the horizon to be illuminated in every azimuth by turns, and the light is not a waxing and waning one, but commences and terminates with a flash. There is another reflector contrived so as to give a series of flashes during the period that the light remains in view; but the effect of this was not practically exhibited.

The effect of the light shining in the focus of an ordinary silvered parabolic reflector was exhibited at night. The

brilliance of the illumination obtained at the distance of a mile was surprising, and the beam from the mirror was comprised within very small limits—not many paces.

Professor Holmes exhibited his steam trumpets also, which he proposes for use as fog signals. My attention was first attracted by the noise when within an hotel more than a mile distant. It was subsequently found that the origin of the continuous sound had given rise to many conjectures among the inmates of the said hotel. At the works there are three of these instruments, the construction of which was explained, and which require but a small quantity of steam to produce the sound. A steam whistle also on the same premises requires a much larger quantity of force to work it, and produces less noise. The trumpets can be tuned at will, and so made as to produce whatever note is found to be heard at the greatest distance. When one of them was blown in the direction of the Thames, and the steam suddenly turned off, a double reverberation was heard from the hills on the other side of the river.

J. H. GLADSTONE.

Fog signal.

Steam trumpet.

CIRCULAR TO ADMIRALTY CHART AGENTS.

The Lords Commissioners of the Admiralty being desirous to take steps for ensuring that the Admiralty Charts in the hands of the several chart agents be kept corrected up to the latest date, and with a view to placing the sale of the Admiralty Charts generally on a better footing, so as to render them more accessible to the public, have sanctioned the following regulations, a copy of which is herewith transmitted for your guidance.

1. The Admiralty Charts are to be sold at the prices engraved respectively on the face of them.

2. The charts in future will be supplied backed and labelled, and the lights coloured, and no charge is to be made for the backing.

3. A commission of 33 per cent. will be allowed on sales, which is to cover all expenses.

4. Printed copies of Notices to Mariners respecting new or altered lights, and Hydrographic Notices of any shoal, or rock, or channel discovered, that affect your neighbourhood, will, in future, be transmitted to you as soon as published at the Admiralty. All those printed since the beginning of the present year are sent herewith.

5. Immediately on the receipt of such notices you are to employ a *competent* person to insert neatly the necessary correction in each copy of the chart affected by it that may be in your possession. In case of a new light it is to be coloured as are the other lights in the charts.

6. You are strictly enjoined not to sell a copy of the chart in question until this has been done. And you are

also to give the purchaser a copy of the notice, and to call his attention to the correction.

7. In order to facilitate the insertion of the above corrections, the titles and nos. of the charts affected are marked on each notice. Generally speaking a single copy of a chart can be corrected in a few minutes. When the corrections are extensive the chart will be cancelled, and new chart will be sent to replace it.

8. Cancelled charts are in all cases to be immediately returned to the Principal Chart Agent in London, when their cost will be allowed for.

9. A moderate charge for time employed in correcting the charts may be deducted from the account of sales and accounted for in the bill.

10. You are to stamp or paste upon the face of every chart a label containing your name and address, and write in the date on which it is sold, as for example :

W. JOHNSON, LIVERPOOL. 1 March 1861.
--

11. You will place in some conspicuous part of your premises a board or placard with the words "Agent for the Sale of Admiralty Charts," painted thereon.

By command of their Lordships,

JOHN WASHINGTON, Hydrographer.

Hydrographic Office, Admiralty,
London.

5 February 1861.

ELECTRIC LIGHT.

FURTHER REMARKS by the ASTRONOMER ROYAL on the Adoption of the Magneto-electric Light.

Royal Observatory Greenwich,

London, S.E., 9th April 1861.

MY DEAR SIR,

I HAVE perused the evidence of Professor Holmes, given to the Commissioners on January 2d, and have been much interested with it. It proves beyond doubt the practicability of the application of the magneto-galvanic light to all the purposes of lighthouses for illumination of the distant horizon; for illumination of the near sea, and for the purposes of revolving lights. In regard to the last, I am surprised that any difficulty has presented itself; the galvanic light is as applicable to revolving lights as to fixed lights, requiring only pretty good mechanical workmanship in the rotatory parts.

In some of the optical explanations given in the evidence to which I allude, there is a little inaccuracy. Thus, the rule given for the adjustment of the central lens in the answer to question 610 is erroneous; the position of the inner surface as reflecting back the light being very unimportant, while in reality all depends upon its elevation with reference to the elevation of the lamp. And the rules for adjusting the prisms are not perfectly accurate.

In fact, I found by internal inspection of the South Foreland high lighthouse, and also by external comparison of the light of the high lighthouse with that of the low lighthouse, that the optical parts of the high lighthouse even now are ill adjusted, though probably in a better state than before Professor Holmes examined them.

I entirely agree with Professor Holmes in his strong condemnation of the selection of the Dungeness lighthouse as a place for trial of the magneto-galvanic light. It is certainly the worst station for that purpose (except, perhaps, the Spurn) in the whole circumference of Britain.

I am, my dear Sir,

Yours very truly,

Admiral W. A. B. Hamilton,
&c. &c. &c.

G. B. AIRY.

ELECTRIC LIGHT TO BE USED IN FRANCE.

The following paragraph states that the French Government are about to use the electric light to some extent.

The Commission have no time to inform themselves of the facts; but they reprint the paragraph in order that attention may be drawn to the subject.

"The Minister of Marine has decided to establish eight electric lights on the coast of the department of the Seine Inférieure. These eight lights are to be placed at Cape de la Heve, Cape Antifer, Etretat, Fécamp, St. Valery-en-Caux, the point of Ailly, Dieppe, and Treport. The object of these lights is to maintain a communication with ships within sight of land, and to transmit the news rapidly to the interior. A contract was concluded at the Marine-office at Havre on Saturday last for the construction of these eight lights."

EXPLANATION OF THE DRAWINGS.

Plate 1. LIGHTHOUSE FLAMES AND TRANSPARENT LANDSCAPE.

The transparent landscape is traced from photographs taken for the purpose at Whitby on the 9th of August 1860, and subsequently enlarged to scale.

The small circles on and above the horizon represent the sun at various altitudes, and are taken from a photograph made July 13, to give a scale. The image is of the same size as that which is formed in the focus of a first order lighthouse lens, and roughly represents half a degree on a circle with a radius of 0.920 millimetres, which is the focal length of such a lens.

The South Whitby Lighthouse, which is represented, was photographed from a point a few inches above the top rail of the North Lighthouse, which is on the same level, and distant 774 feet.

The elevation of the light above the sea level is 240 feet. The top rail is the level or geometrical horizon. The place where the sea horizon cuts the tower marks the angle of dip.

The height of the South Lighthouse from base to vane is 48 feet.

The passing ships were either represented in the photographs, or their positions were marked on ground glass placed on the burners in the Lighthouses.

The wreck was not seen, but a wreck had taken place near the spot shortly before the Commissioners visited Whitby, and sailors complained that the light was hidden, by "the gallery," as they imagined.

The lines parallel to the horizon give a scale of degrees, constructed from a circle with a radius equal to the focal length of the Lighthouse lens; and from this scale, distances on the sea can be ascertained by inspection of the table calculated by Mr. Chance from data furnished to him by Captain Ryder.

The drawings of Lighthouse flames are of the full natural size.

The original drawings were taken either from enlarged photographs of the flames, or from drawings made by eye, and by measurement in the several lighthouses named, or by tracing, on ground, glass the image of the flame formed by a small lens.

This last method was suggested by Professor Faraday on the 13th of October 1860, and was used by him in preparing the drawing of the Whitby flame, which is copied from his report to the Trinity House.

The six drawings of Lighthouse flames are so placed that a straight line cuts them all at the distance above the burners at which the image of the visible horizon was actually formed by the lenses of the several lighthouses named, when they were visited and inspected by the Commission.

The transparent landscape is so placed that the sea horizon coincides with the straight lines which cut the flames, and the circle in each flame marks the chief focus, and the position and size of the sun's image in the flame, when it is lighted at sunset, if the sun is visible in the proper direction on the sea horizon.

The whole is intended to show roughly, but with tolerable accuracy, what portions of the landscape would be illuminated by flames of various shapes and sizes, which really existed in the lighthouses named—if such flames were placed in the North Whitby Lighthouse, at an elevation of 240 feet above the sea level, and there placed with reference to the refracting portions of the apparatus, and the visible horizon of the image formed by it, in the same position as the flames in question really occupied when they were drawn.

Thus an observer *above* the South Whitby Lighthouse would see a good light, and one at the end of the dwelling-house would see light from the points of the flame in the North Lighthouse, through the refract-

ing band; and an observer in the field near the lower wall would see *no* light from such a flame; but if the landscape be turned over the *Calais flame*, the points reach nearly to the nearest wall, and such a light so placed with reference to the horizon, would be seen from the wall where the small flame was invisible, while an observer on the horizon would see the brightest part of the flame.

The image of a steamer passed along the ground glass which was placed on the burner at the North Whitby Lighthouse on the 9th of August, 1860, while the Commissioners were making their observations. The position of the image of the steamer was marked with a pencil, and it is represented in the transparent drawing, three inches above the burner at the Start. No light at all could have reached that steamer through the refracting bands of the apparatus at the North Whitby Lighthouse, from flames such as those which were found at the Start and Minchhead, and hardly any light could get to the steamer from the lamp actually used at North Whitby (see drawing).

These drawings are fair representations of the flames produced by using a fountain lamp, and suppressing one of the four wicks,—which was the almost universal practice in using dioptric apparatus in England and Ireland, when the Commission was appointed. The practice was different in France and in Scotland.

It will be found on reference to former pages, that observations made by day from within were tested at night by looking at the lighthouse from ascertained points outside, and that the observations so made proved each other.

This drawing relates only to the refracting portions of the apparatus, but similar drawings could be made for all parts, and sketches have been made.

Plate 2. DRAWINGS OF THE AVERAGE SCOTCH AND ENGLISH FLAMES AND OF THE ELECTRIC LIGHT.

These were taken from photographs, and may be here compared with each other, and with the diagram (No. 3), which shows the consumption of oil in each lighthouse under the three General Lighthouse Authorities.

The electric light is represented of full size, beside the full-sized lighthouse flames as now exhibited in France and Scotland, and in England and Ireland. The drawing shows how unfit the large apparatus constructed for large flames, must be for such a minute spark as the magneto-electric light, and how necessary it was to make some special arrangement to cause vertical divergence at the South Foreland, when the electric light was exhibited there in a first order dioptric apparatus.

It will be seen that the light is rather smaller than the image of the sun on the scale, which is placed near it for comparison; and it follows that in a well made large lens, no light could reach the sea from such a light, placed on a *level* in the focus.

An enlarged representation of the electric light is also given to show its general appearance more distinctly. It is magnified about 25 times.

The scale was thus constructed:—a photographic camera (with a small stop touching the lens outside) was directed towards the sun on a clear day, about noon, and carefully focused; and a sensitive plate was placed in the slide in the usual way.

The cap of the lens was then taken off and replaced instantaneously, and the time noted; and the operation was repeated at intervals during 20 minutes; after which the plate was developed in the usual way.

The sun's apparent semi-diameter on the meridian, for the day in question, is given in the nautical almanack ; and gives the sun's apparent diameter as $31' 32''$, 4, or very nearly half a degree on the centre of the sensitive plate, and it gives a scale for all photographs taken with that lens, at that focal distance.

The sun moved half a degree along a given path in two minutes of time, a whole degree in four minutes, and five degrees in twenty minutes ; which gives another scale of degrees of a smaller circle nearly parallel to the equator.

All the landscapes were taken with the same camera, at the same focal distance as the solar scale, but they were taken on a flat surface, and they are consequently distorted to a certain amount.

The lens was small, and the pictures had to be enlarged to represent the image formed by a Lighthouse lens.

The length of half a degree on a circle, with a radius equal to the focal lengths of a first order Lighthouse lens, (0.920 millimeters, as given in the French returns), being ascertained, the solar photographic scale was enlarged in a camera with the same lens reversed, and it was enlarged so that the diameter of the sun's image nearly coincided with half a degree, and the scale so enlarged was photographed, and is given in Plate 2.

A negative of a landscape was then substituted for the negative of the solar scale, and printed by the same process, at the same distance, and a tracing was made from the photographs so taken, and the result is given in Plate 1.

The Landscape represents the image formed by the lens.

The instrument used was not such as to ensure very great accuracy, but the result is not far from the truth.

Plate 3. DIAGRAM SHOWING THE CONSUMPTION OF OIL IN LIGHTHOUSES UNDER THE THREE GENERAL AUTHORITIES. (To face Plate 2.) *Drawings.*

The vertical scale in this drawing represents the number of gallons consumed in 1857, and each column a Lighthouse. The horizontal scale corresponds with the numbers on the Map ; thus I. is the Fern, the first in England ; LXXXIII., the Calf of Man, the first in Scotland ; and CXXIX., Pool Beg, the first in Ireland.

Plate 4. represents the same lighthouses arranged in the same order. The vertical scale shows the income and expenditure for each light. See page 120, Vol. I., for remarks on this diagram.

Plate 5. MAP OF THE UNITED KINGDOM,—showing stations of coast guard ships of war, head quarters of divisions, and "coast guard stations."

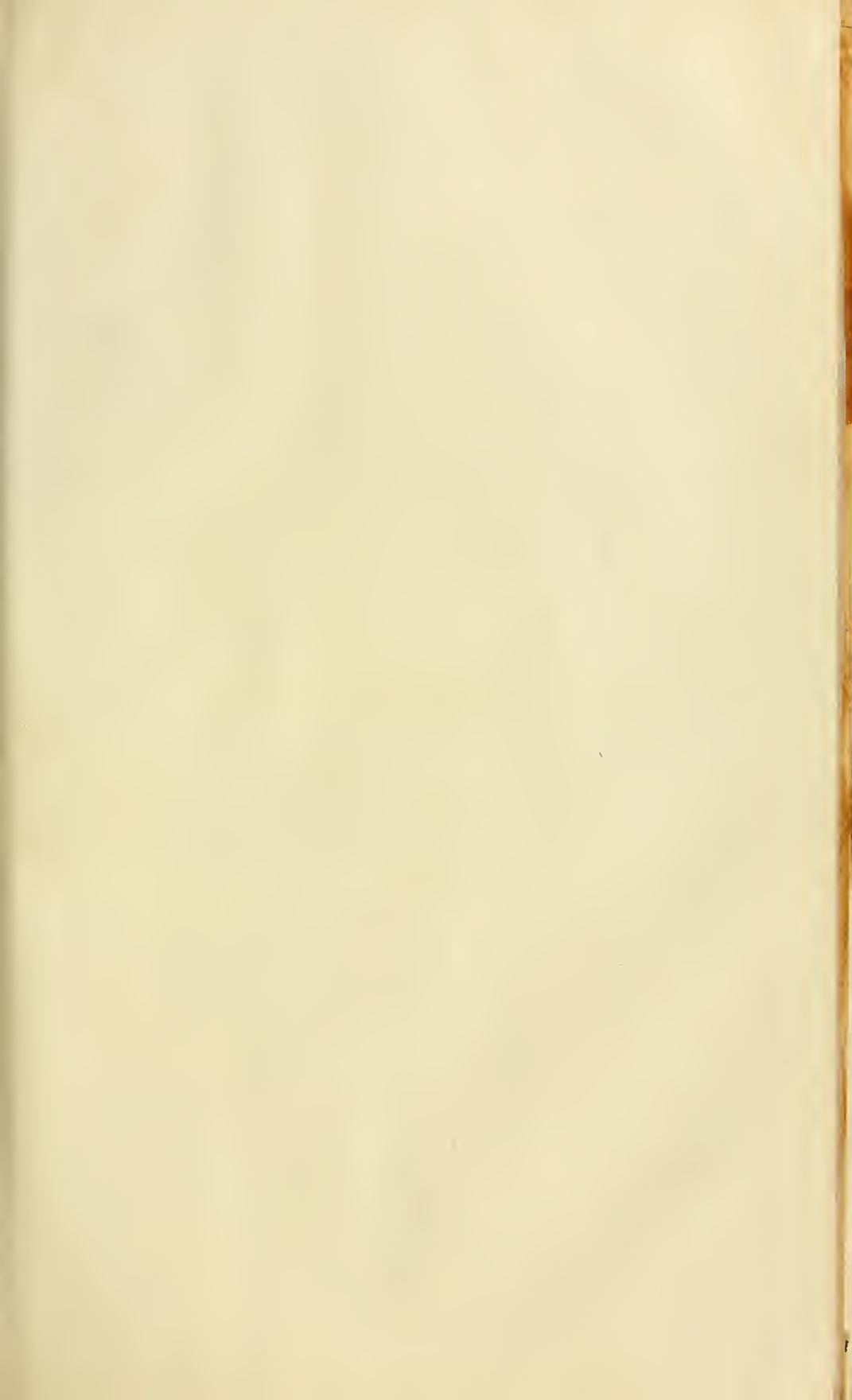
Plate 6. INDEX MAP,—showing, 1st, the position, range, character, and colour of lights in the United Kingdom.

2d. The names of places at which there are local authorities having charge of lights, buoys, and beacons. See explanation on the map itself.

The whole of these drawings are shaded on one principle. Oil is shown as light on a dark ground ; as that from which light is produced. The flames, as the sources of light, are shown light on a dark ground, and the ranges of the lighthouses are represented as disks and portions of disks of light on a dark sea.

The radius of each circle on the map shows the distance at which "a light is visible from the horizon," in clear weather ; as shown on a map published "by order of the Board of Trade."

LONDON:
Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty.
For Her Majesty's Stationery Office.



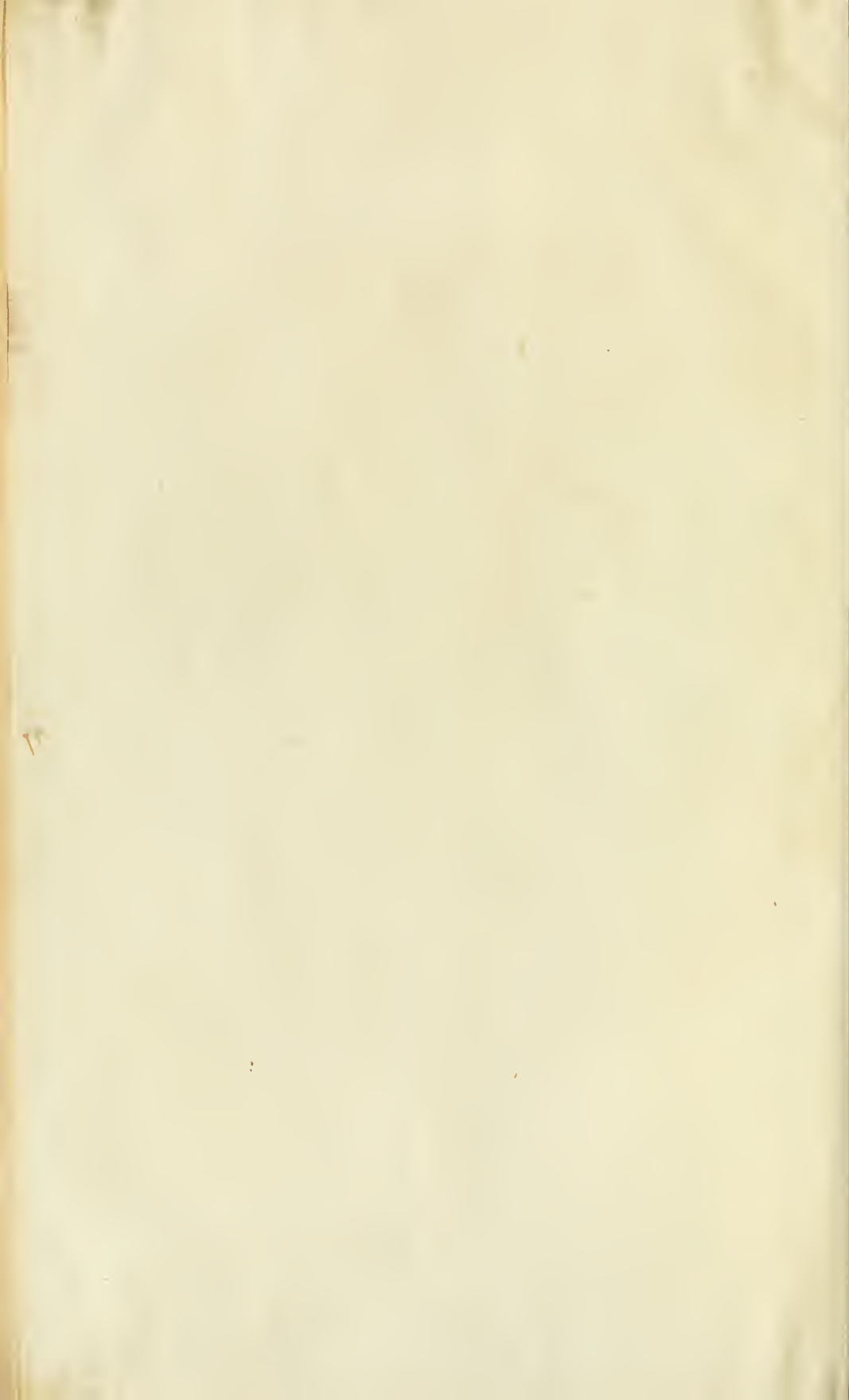






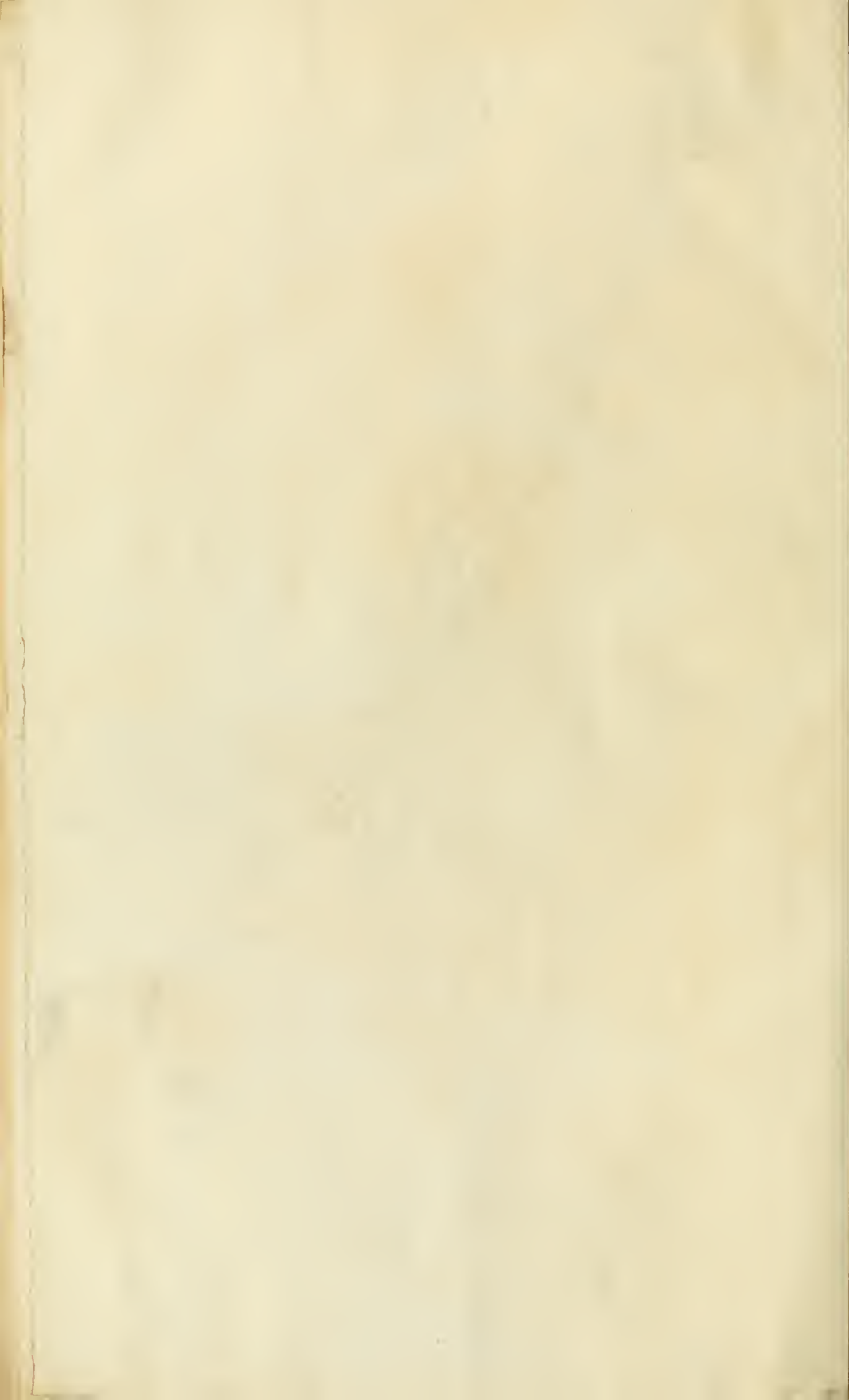


all degrees equally about
63 N. 10 W. 6.15.50



S Light-house. &c
 at
 Whitby.
 From a Photographs
 taken from the Gallery of
 the N Light-house.
 Elevation of both the
 same 240 feet.









Royal Commission,

Lights, Buoy, and Beacon,

7, Millbank Street, S.W.

London.

Feb. 4/61

per rec. Feb 5/61.

to be proceeded with -

Instructions for making the Scale on
the transparent Ranielscape -

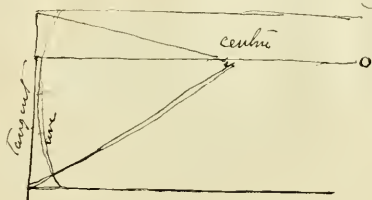
From a point on the level.

Strike a circle with a radius of $0^m.920$
and divide ^{in degrees} ~~the~~ circle ^{above and below the}
level line -

Draw a line at right angles to the level
touching the circle -

From the centre of the circle ^{draw} ~~produce~~ radii
through the degree divisions & produce
them till they cut the tangent at certain points

From these last points draw lines
parallel to the level. They are the Scale of degrees. -



I am not quite sure that the scale on my
drawing is quite correctly done. Please to test it on the Stone
S.F.C.



North 7 on page No XXIX

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1945 Jan 9 1942 in 1940 1943
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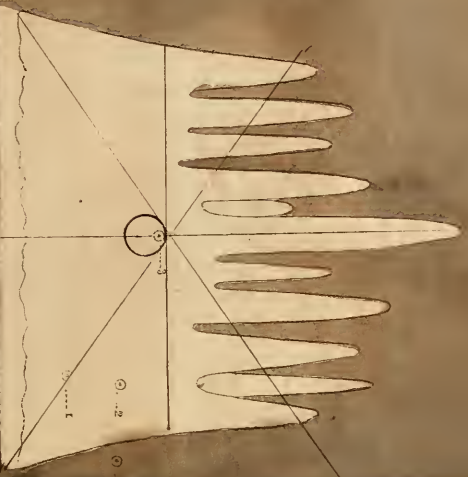
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North Wilcox No VI

See Report of Experiments at Wilting, 19th October 1860.

South Portland. high. N° XXX
Elevation 372 feet.
3 point measurement on a steel & Tinsins on ground
glass, made in the light house plane 20 1860
3 Wicks used (over 500)



Traced on ground glass Nov 2 1860
in a camera obscura.
fourteen lamps
3 weeks use of 1000 lbs
consumption of oil 457 lbs



of mounting

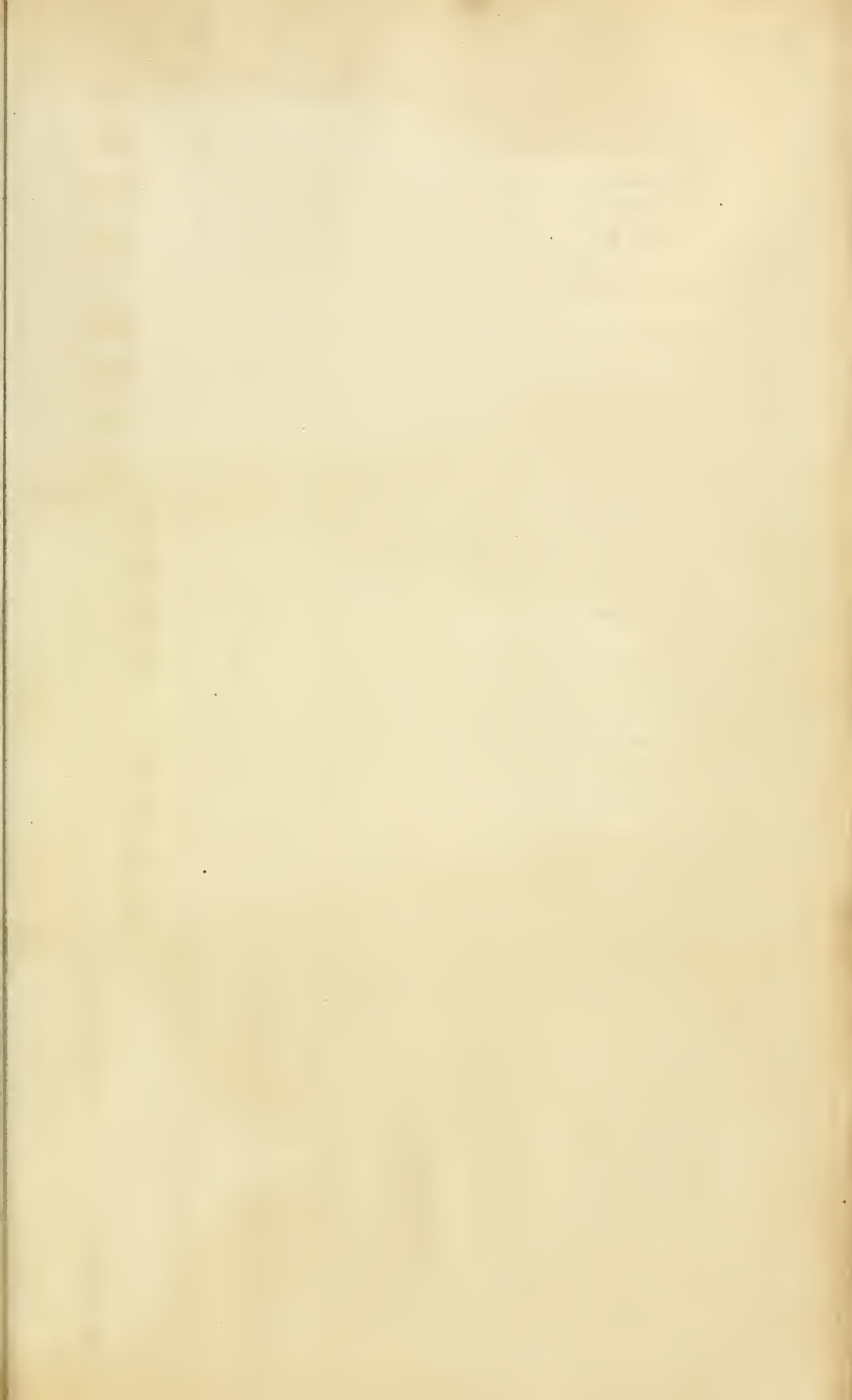
Instructions for making the drawings of
flames. —

Make all the Division Lines correspond —
and so fasten the drawings together when
complete that the transparent drawing
may be over the one or the other of
the drawings of flames. ^{& correspond with both} as at present.

See the Scale as directed on the other
side. —

The drawings of flames to be done in
clear lines so far as they represent
the burner & work. The outline of the
flame itself to be given with the
Colours Stone. —

The Landscape to be done in outline
on transparent paper or transparent
cloth if that material will suit better.

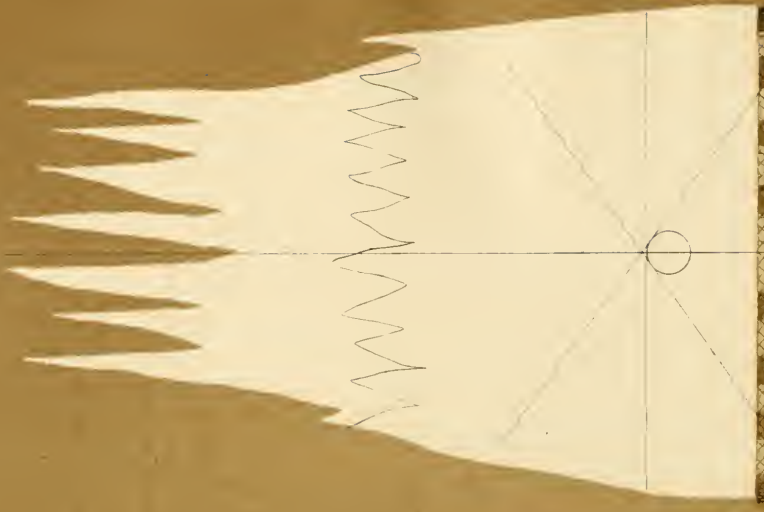




START. N° XLIX, Vol. II, p. 86.
Elevation 20h Fred.
Sketch Mar. 9 1860.



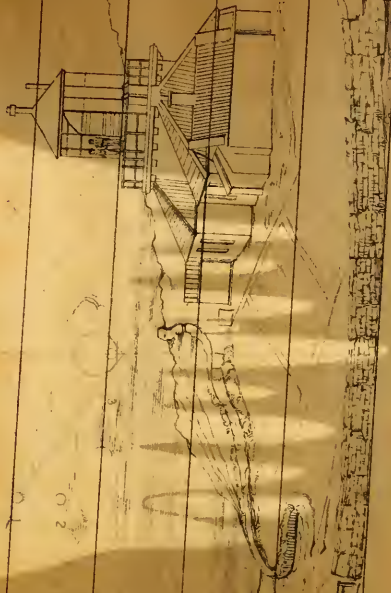
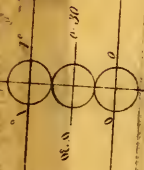
NORTH FORELAND. N° XXIX, Vol. II, p. 79.
Elevation 20h Fred.
From Measurement and an eye sketch. June 5, 1860
New Pressure Lamp.
4 Wicks used
In 234 Litres 25 Gallons in
consumption of Oil 4 p. 380 Gallons.



CALAIS AND CRISNEZ. Page 194
From Measurement and an eye sketch. June 1849 1860
Pump Lamp with Special Chimney,
4 Wicks used
Consumption of Oil 785 Gallons

FOOTLIGHT BY N.Y. J. 1886

CONSTRUCTION OF THE LIGHT



See Light House returns VI & VII at page 67 Vol II.
 S. Whoby from a Photograph taken from the gallery of
 S. Whoby distant 774 feet

Elevation above the Sea equals
 Height of S. Light House from base to Vane 48 feet
 August 9, 1860

Scales in degrees of a circle Radius 0^m 920.

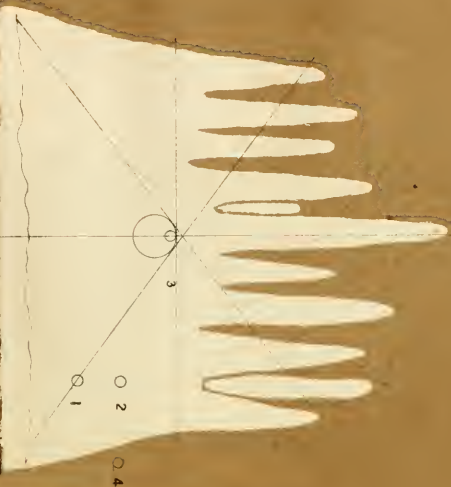
Focal length Radius 0^m 920.

[illegible]

ART, NEW YORK, N.Y.

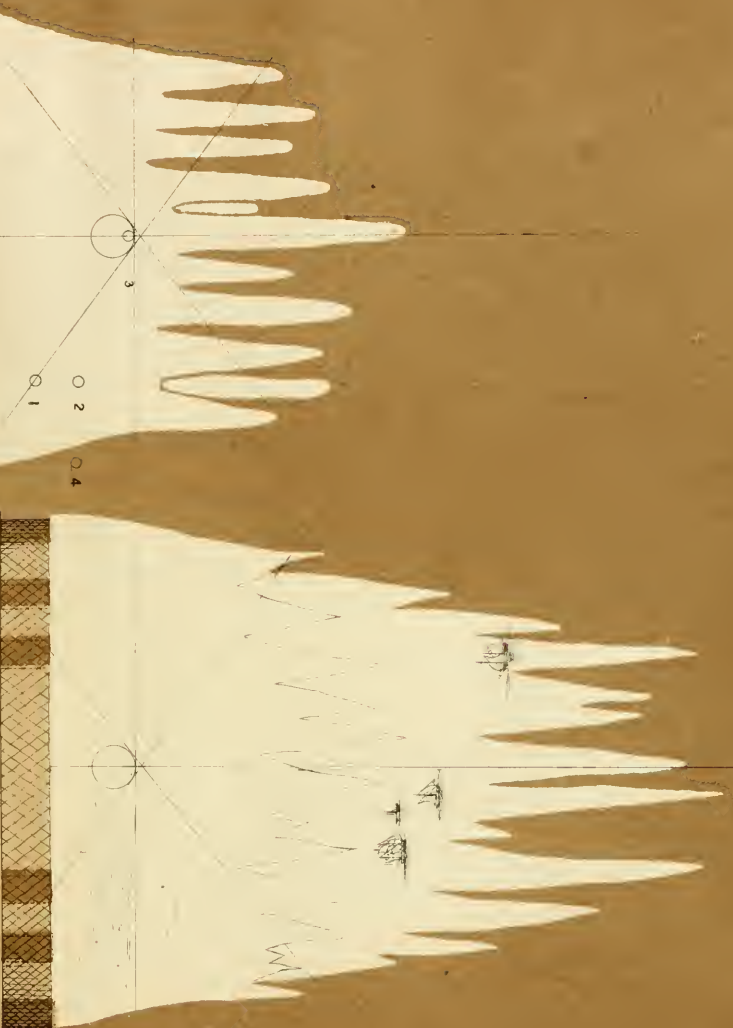
CLASSICAL CHINESE

5 O
6 O



NORTH WHITEY, NO VI. Vol. II. P. 62.
Elevation 210 feet.

5 O
6 O



SOUTH FORELAND, NO XXX. Vol. II. P. 79.
Elevation 379 feet.
From Measurement and eye-sketch and tracings on ground glass, made in the light house-tower 30 1866.

From Measurement and eye-sketch and tracings on ground glass, made in the light house-tower 30 1866.
Fountain Lamp
3 Wicks used
(Consumption of Oil [1857-58] 494) Gallons.

The burner was asked to make the best flame he could.

MINE HEAD, NO CXL. Vol. II. P. 233.
Elevation 285 feet.



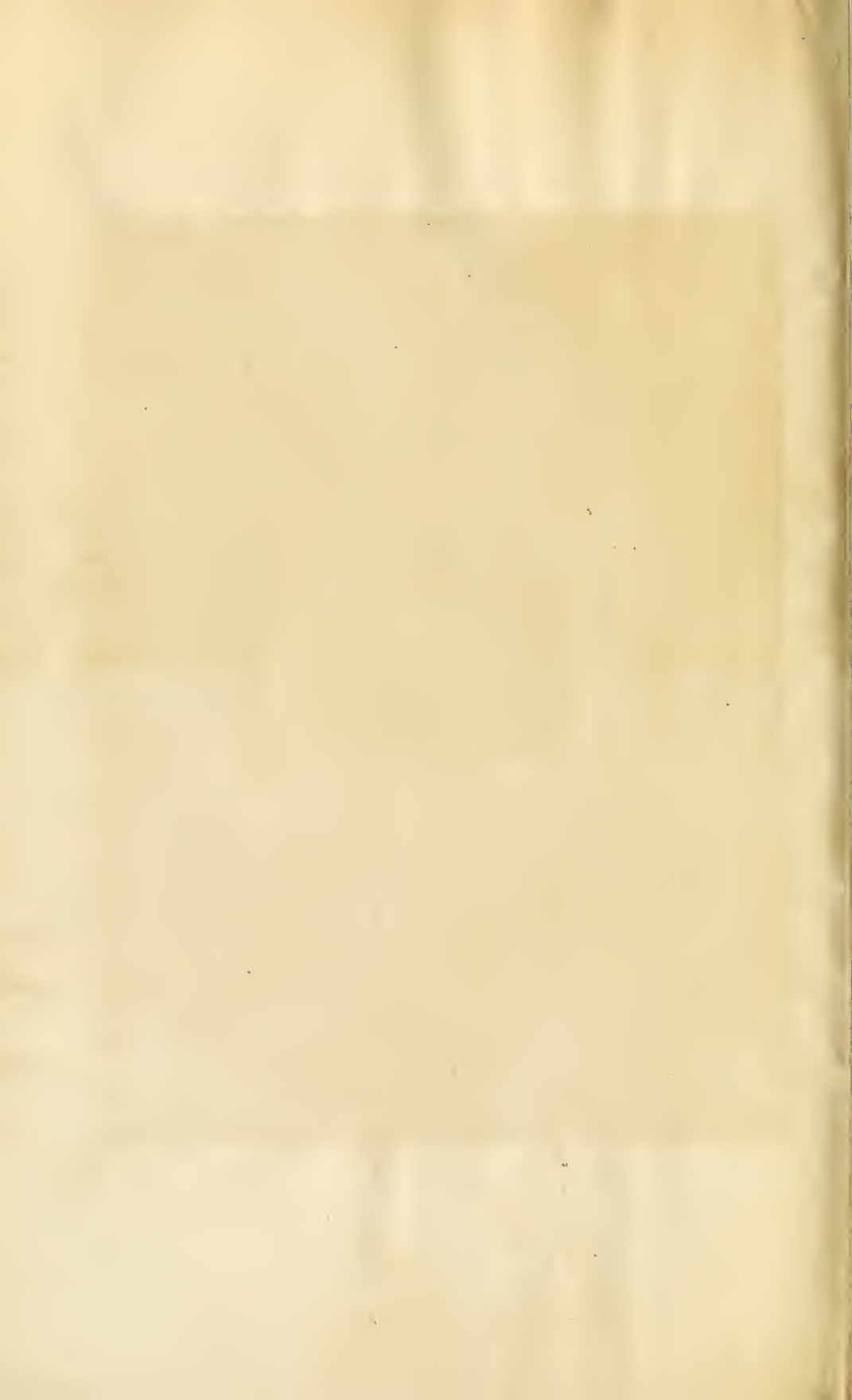
Drawn on Ground Glass Nov. 2, 1866 in a Camera Obscura.
Fountain Lamp
3 Wicks used
(Consumption of Oil [1857-58] 487) Gallons.











average size of flowers used in first order.
 Decid. the appearance in capture and Ireland
 (as indicated by the photograph taken in the spring of 1865)
 the number of the leaves of the plant is about
 100. The leaves are green & darkly above.
 over deep the flower
 refraction rates in the light shown in
 convergence of the shape of the flower.

Electricity
 from the battery



Electricity
 from the battery
 from the battery
 from the battery

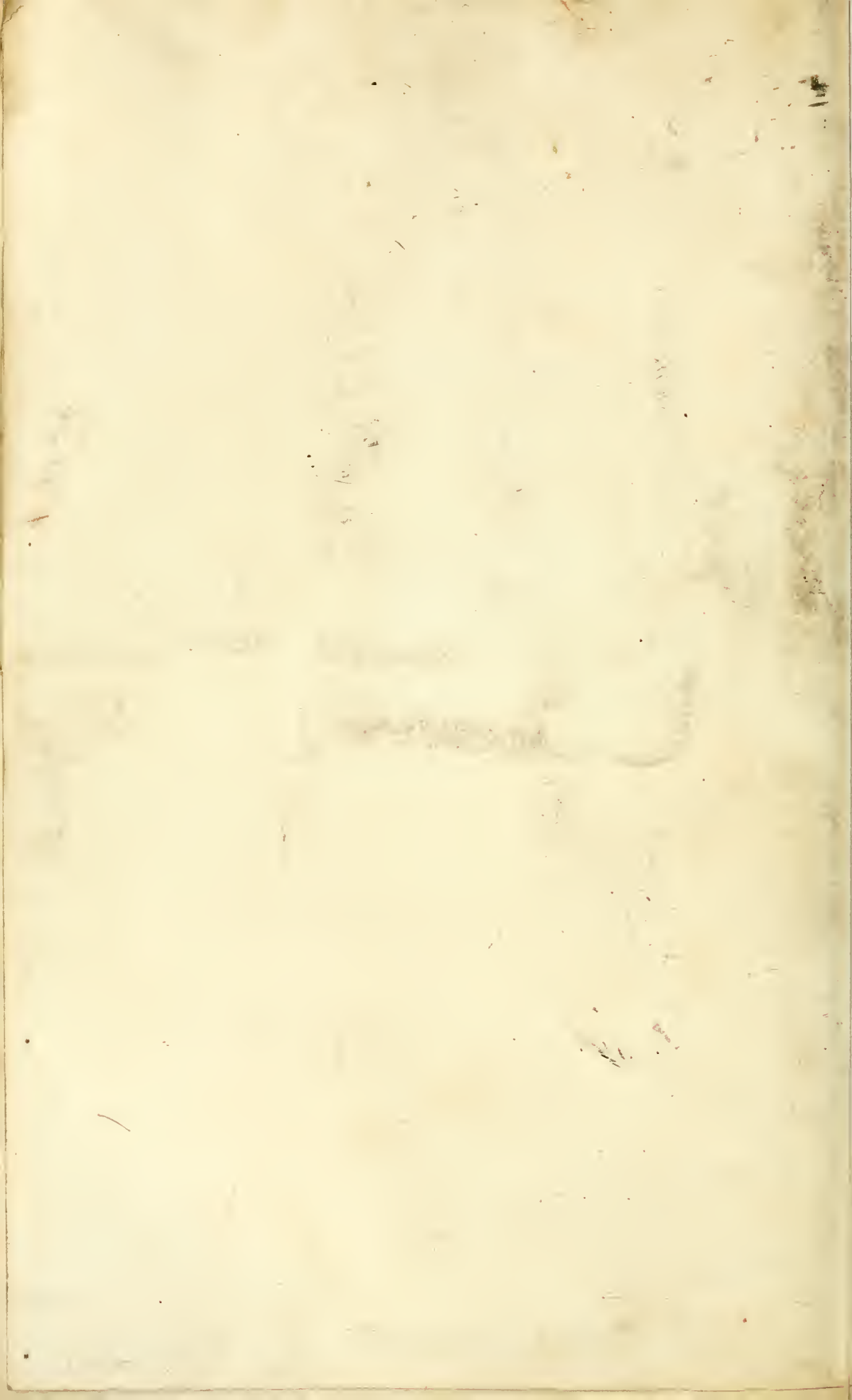
degrees on the sun's path with 13. 60
 0 10 20 30 30 30
 Scale, in a camera 10 = 0.44 millimeters
 Photographs taken from the sun's path with 13. 60
 minutes of time on the sun's path with 13. 60
 Scale, in a camera 10 = 0.44 millimeters

Scale, 10 on
 the vertical
 31 32 33 34 35

On the vertical, sun's apparent
 diameter 10. 13. 60

in the focus of
 light house lens

10 = 0.44 millimeters
 Sun = 0.44 millimeters



Prewig of flames
finished. Feb 4/61.

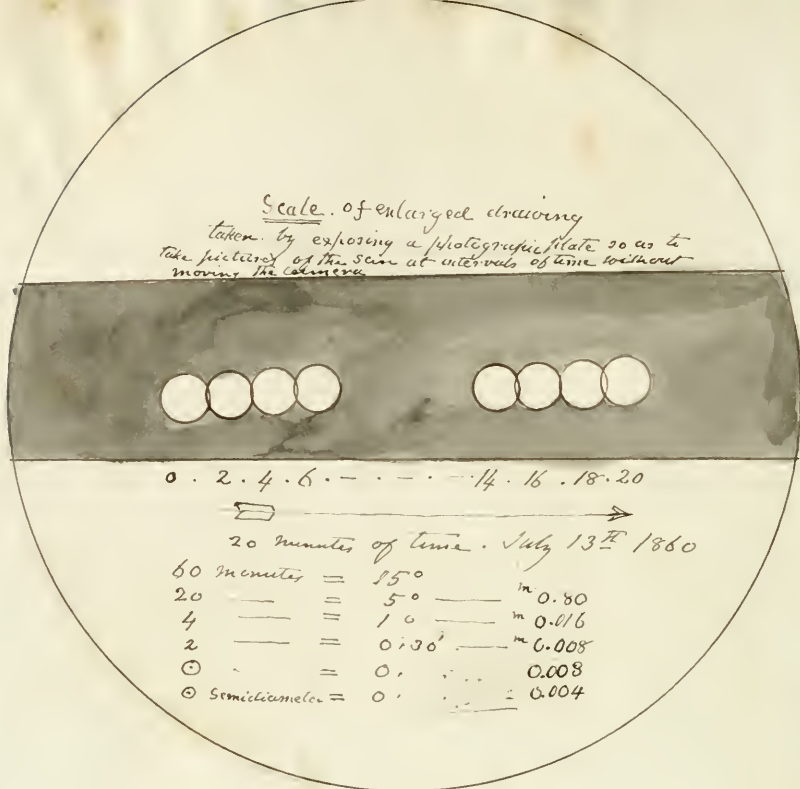
~~HP~~

Instruction for Scale
on.
transparencies - drawing - Landscape
From a point on the level. — 0

Strike a circle with a radius
of 0^m. 920. millimetres.
and divide an arc of 3° and
3° above & below the level line.

Draw a line at right angles to
the level, touching the circle.

Produce the radii ~~to the~~
till they cut the tangent. &
from the points where they
cut rule lines parallel to
the level.



Explanation.

The transverse drawing is taken from
enlarged images of several photographs all
taken ^{for the purpose} with the same lens, at the same focal
distance; and all enlarged to the same amount.

The image of the sun gives the scale, and is of
the same size as the image of the sun at sun rise or sunset above the horizon of a light-house lens.
The drawing represents the image formed in the
focus of a first order light-house lens, which
has a focal length of ^m 0.920 or nearly 3 feet.
A radius of ^m 0.98 inches subtends ^m 1° or 0.01580555
~~consequently, the sun in the drawing may~~
~~be taken to equal 0°30' = 0.008~~

The landscape represents the South Wherry Light-house
whose light is 240^{ft} above the sea level as
^{on the 9th June 1860 per a spirit level a few inches above}
photographed ~~from~~ the level of the top rail
of the gallery of the North light-house which
is distant 774 feet.

A camera is represented in a similar position
in the gallery of the South light-house, &
which is at the same level. In sequence from the
camera to the horizon is the angle of dip.

The passing ships were either represented in the Photographs or their positions were ascertained by marking the position of the images ^{of ships, actually passing} formed on ground glass placed on the burner, inside the lens of the light-house. see page 1

The wreck was not visible when the Commission visited Whitby, but a wreck had taken place near the Spit.

A scale of degrees is ~~distances are marked on the sea~~ ^{by which distances may be calculated}. ~~also calculated from a table prepared by the help of the table prepared by Mr. C. B. from data furnished to him by Captain Agden.~~

Agden —

The drawings of light-house flames are of the full natural size. —

The original drawings were taken either from enlarged photographs of the flames — or from drawings made by eye & measurement in the light-houses named; or by tracing on ground glass the image of the flame formed by a lens. The last method was ^{suggested to the Commission} by Professor Faraday on the 13th of Oct. 1860

The drawings of flames are so placed that the horizon of the transparent drawing may cut the flame at the ~~same~~ distance above the burner at which the image of the true horizon was actually found to be situated at each light-house.

The whole is intended to show ^{roughly} what portions of the sea ⁵⁶⁴ would be illuminated ^{by rays sent on by a reflecting lens} by flames ^{of various shapes & sizes variously placed in behind the lens of} a first order Dioptric apparatus, at an elevation of 240 above the sea level. —

Example. The image of a passing steamer
at least miles passed along the ground
is placed on the burner at the North
Light-House while the Commissioners
were making their observations on the
9th of August 1860

It was 3 inches above the burner and
is so represented in the transparent drawing.

By turning the transparency over the
drawing which represents the flame
seen at the Stand on the λ it will
be found that very little light
~~from such a flame~~
could reach an observer on board
the steamer, ^{from such a flame} but that an observer
on the horizon or
placed on a hill higher than the
line of the horizon would see a
good light.

and it was proved experimentally
that such was the result of the
arrangements at various light houses.
of which ^{North} ~~South~~ Whith was one. —

The greater part of the light produced was
thrown above the horizon & lost on the
sky.

① = 0.30 = in the Photograph as enlarged 9 millimetres.

$$9 = 0.30 \text{ (2)}$$

$$\frac{2}{18} = 10$$

$$\frac{360}{1080}$$

$$\frac{54}{6480} = \text{Circumference.}$$

$$113$$

$$20440$$

$$6480$$

$$6480$$

$$\begin{array}{r} 732240 \\ 7100 \end{array}$$

$$2224$$

$$2130$$

$$940$$

$$710$$

$$2300$$

$$2130$$

$$1700$$

$$1420$$

$$2800$$

$$2485$$

$$3150$$

$$2840$$

$$3100$$

$$2540$$

$$2600$$

$$2485$$

$$1150$$



$$\frac{2}{2.062647887} = \text{diameter.}$$

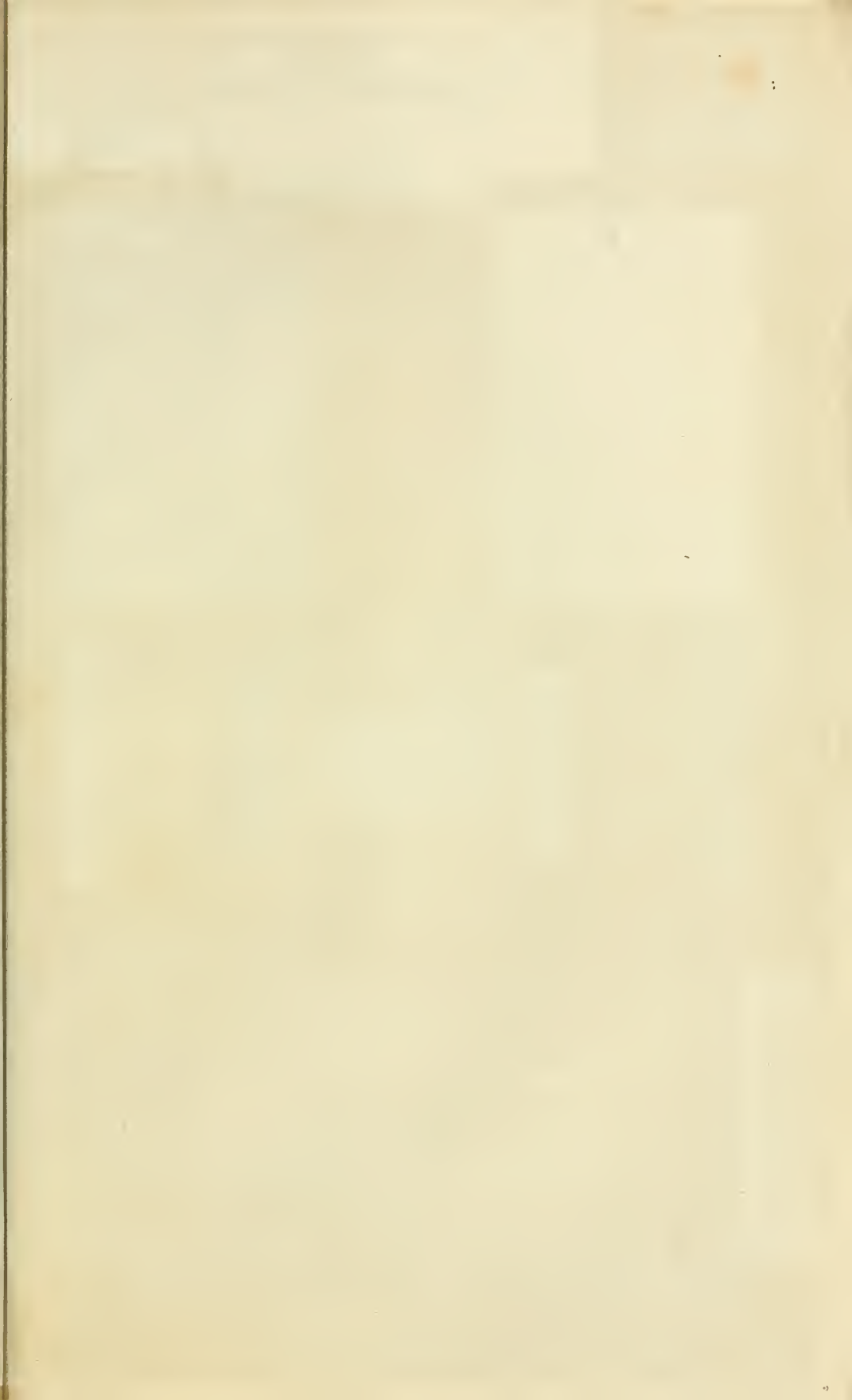
$$\frac{1.031323943}{9} = \text{Radius.}$$

The drawing as enlarged is as though the camera had a focal length of 1.033 millimetres instead of 0.92

11 = 11 millimetres too long a focus. according to the french drawing.

but the point is somewhere inside the glass of the lens. & the drawing is probably about right. Test it by the table.





NORTHERN LIGHTS.

Photograph of 1st Order Flame

FULL SIZE

Edin' Jan'y 1860

Average size of flames used in first order Diaphane Apparatus in England and Ireland, from an enlarged Photograph taken August 7th 1860 in the shape of W.

Without the maker of the lamps. The rings of light and darkness above and across the flame are caused by reflection and refraction in the glass chimney, in consequence of the shape of the shoulder

ELECTRIC LIGHT.

magnified about 25 times

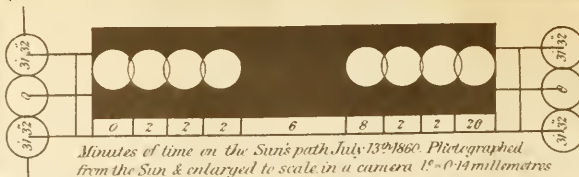


ELECTRIC LIGHT

NATURAL SIZE

From Photographs made by Professor Wallace.

Scale, 1" = 1/2" the Meridian



Minutes of time on the Sun's path, July 13th 1860. Photographed from the Sun & enlarged to scale in a camera 1 1/2" = 0.14 millimeters

Degrees on the sun's path July 13th 1860

Sun's apparent diameter on the Meridian on the 13th July 1860 in the focus of a first order Light house lens 1" = 0.7865 Millimetres Sun = 0.8725

NORTHERN LIGHTS.
Photograph of 1st Order Flame
 FULL SIZE.
Edin.^r Jan^y 1860.

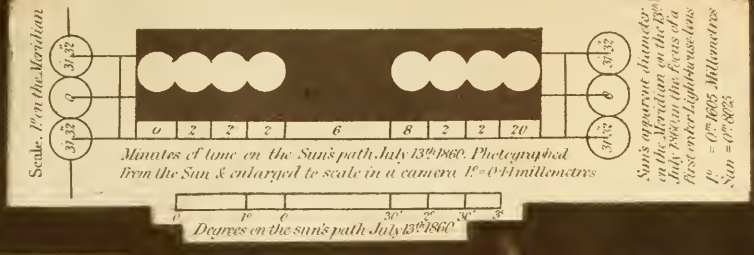
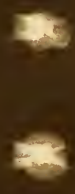


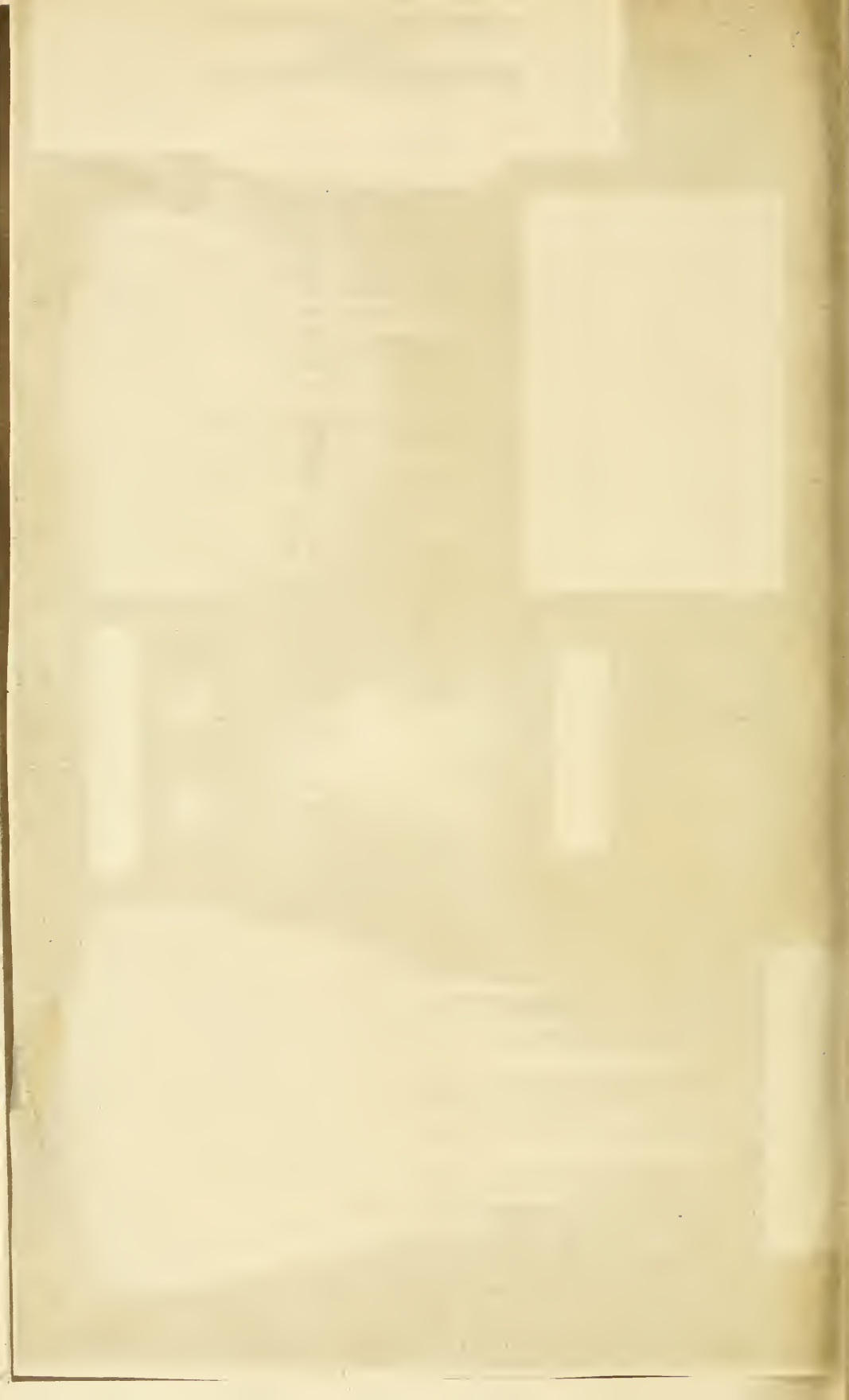
Average size of flames used in first order Dioptric Apparatus in England and Ireland, from an enlarged Photograph taken August 7th 1860 in the shop of. W^r. Wilkins the maker of the Lamps.
The rings of light and darkness above and across the flame are caused by reflection and refraction in the glass chimney in consequence of the shape of the shoulder.

ELECTRIC LIGHT.
magnitud about 25 times



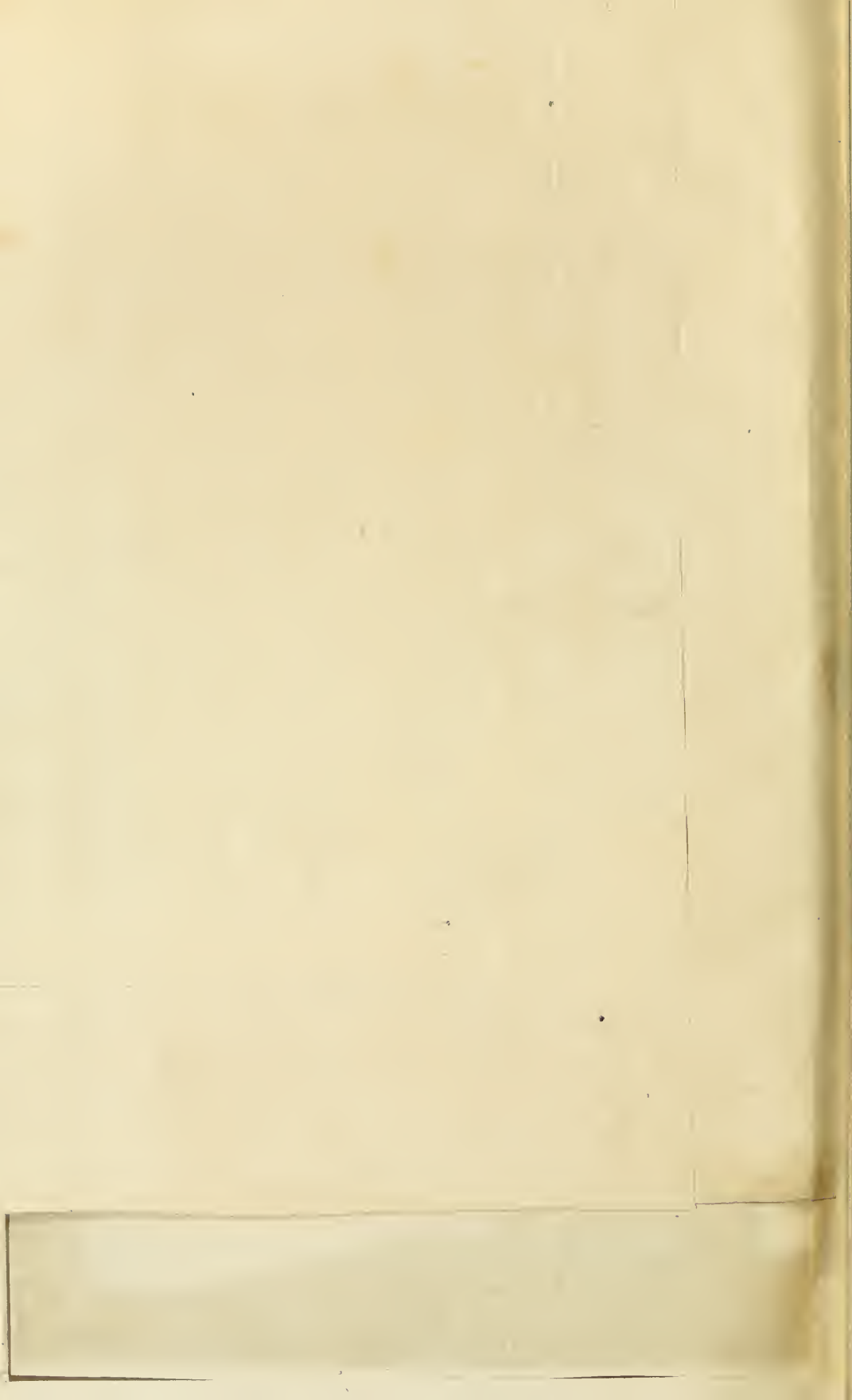
ELECTRIC LIGHT
 NATURAL SIZE
From Photographs made by Professor Holmes.





1050	160	170	180	190	197	200
IRELAND 2518 MILES, 69 LIGHTS.						
ES.						

Day & Son, Litho to the Queen.



LONS, IN 1857.

Fig. 3.

AVERAGE CONSUMPTION OF OIL
AT 1st ORDER DIOPTRIC STATIONS

Scotland 791
France 785
Regulation

England 171
Ireland 142

IRELAND 2518 MILES, 69 LIGHTS.

es.



DIAGRAM SHEWING THE INCOME & THE EXPENDITURE FOR THE LIGHT-HOUSES

INCOME, 1852 RED.
EXPENDITURE 1856 BLACK.

UNDER THE THREE GENERAL AUTHORITIES.

MAXIMUM INCOME "SMALLS" £22,759.
AVERAGE EXPENDITURE ABOUT 350.

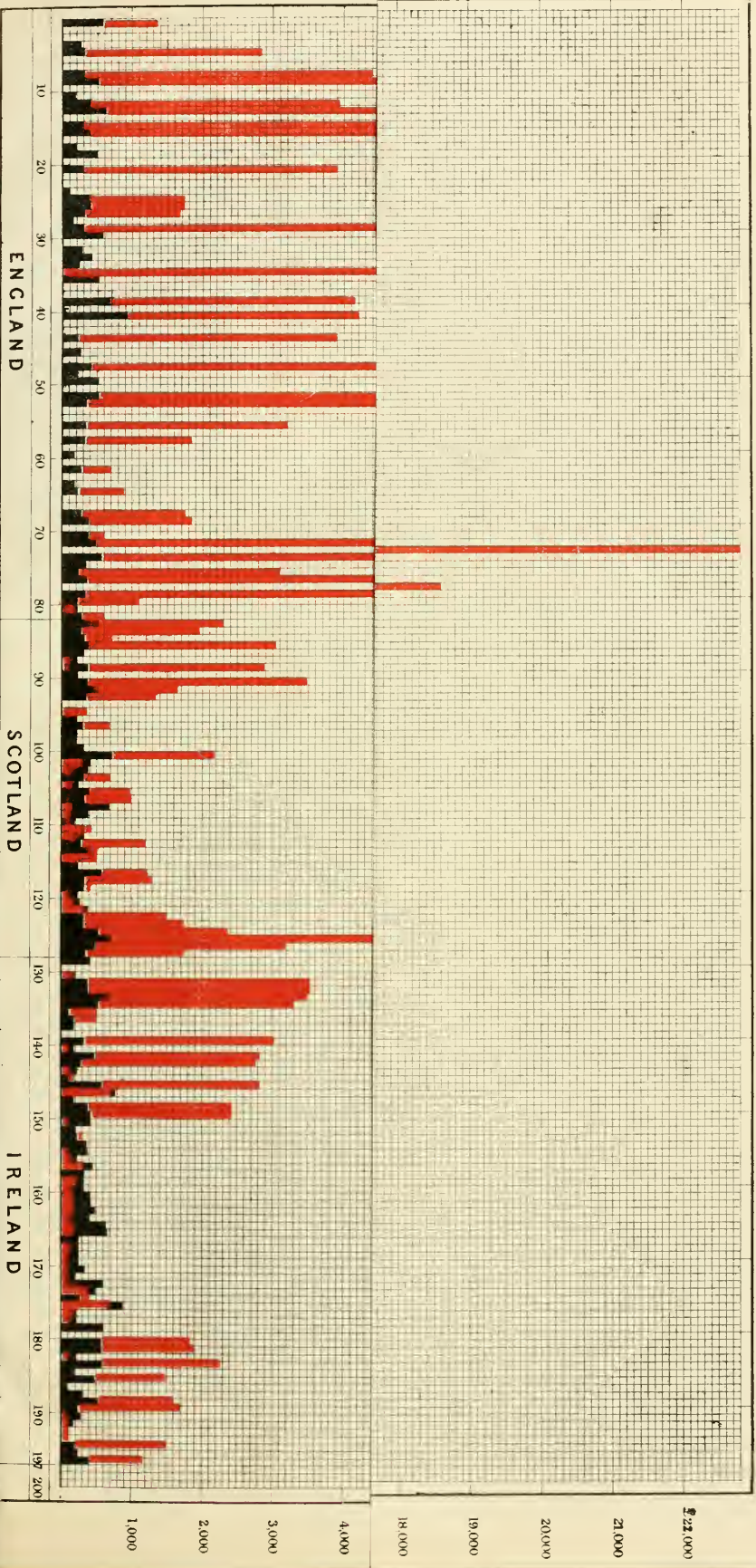




FIG. 4. MAP SHEWING

COAST GUARD STATIONS.

Ships of War stationed
Head Quarters of Divisions
Sailings



Faint. ^{Strong} idea of a map
drawn to show Commission





No 5

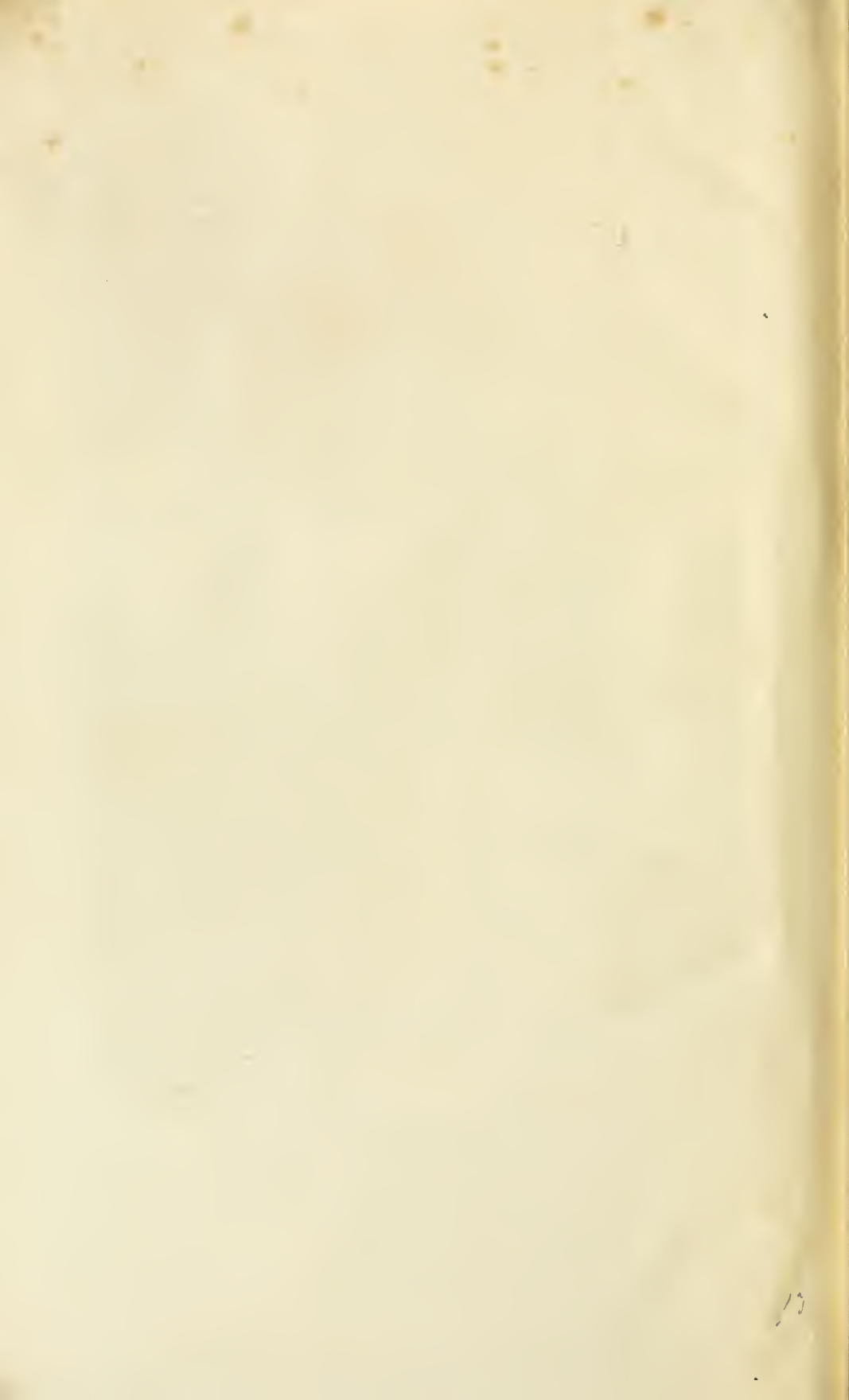
1898

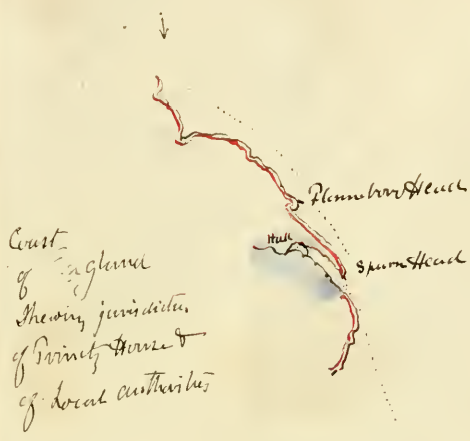
Position, range, character and colour of lights.

1 to 37 (names & numbers on the sea) floating lights under Ditta similarly numbered



Day & Son Lith the Queen





Trinity House jurisdiction marked
by a red line and the names written on
the sea —

Local Authority marked by a
blue wash and the names written on
the land side —

..... Tracks of the Vireo ~~is~~ a dotted line
- - - - - Tracks of members.

